Role of Spirometry in a Comprehensive Asthma Management Program

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Be Extremely

Objectives

- To review the definitions of static and dynamic lung volumes and capacities
- To have a basic understanding of how to properly administer a PFT
- To feel comfortable in the interpretation of PFTs and be able to use them as an aid in the diagnosis of obstructive and restrictive pulmonary disease
- To understand the value of spirometry for asthma diagnosis and management in the primary care setting

Indications
Diagnostic

- Evaluate symptoms, signs, abnormal lab tests
  - Symptoms: cough, wheeze, dyspnea, chest pain
  - Signs: overinflation, cyanosis, wheezing, chest deformity, crackles
  - Lab tests: hypoxemia, hypercapnia, CXR, polycythemia

GIANTS
01

Indications
Diagnostic

- Measure the effect of disease on pulmonary function
- Assess preoperative risk
- Assess prognosis
- Screen patients at risk for lung disease
  - Smokers
  - Occupational exposures
  - Routine physical examination

Indications
Monitoring

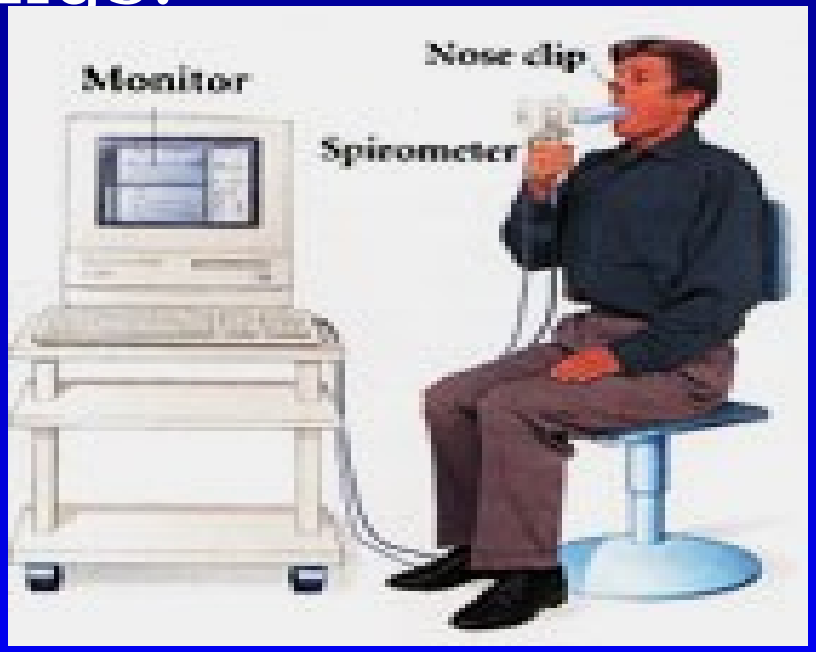
- Effectiveness of therapeutic interventions
  - Bronchodilator
  - Steroids
  - Other
- Provide information on the course of diseases affecting lung function
- Adverse reactions to drugs with known pulmonary toxicity

Background

- Focus on test that can be performed in office setting
- Children > 6 years old
- Reliable results depend on:
  - Experienced tech
  - Devote time / effort to each child
  - Appropriate atmosphere
- Measure
  - Lung volumes
  - Flows and timed volumes
  - Reactivity

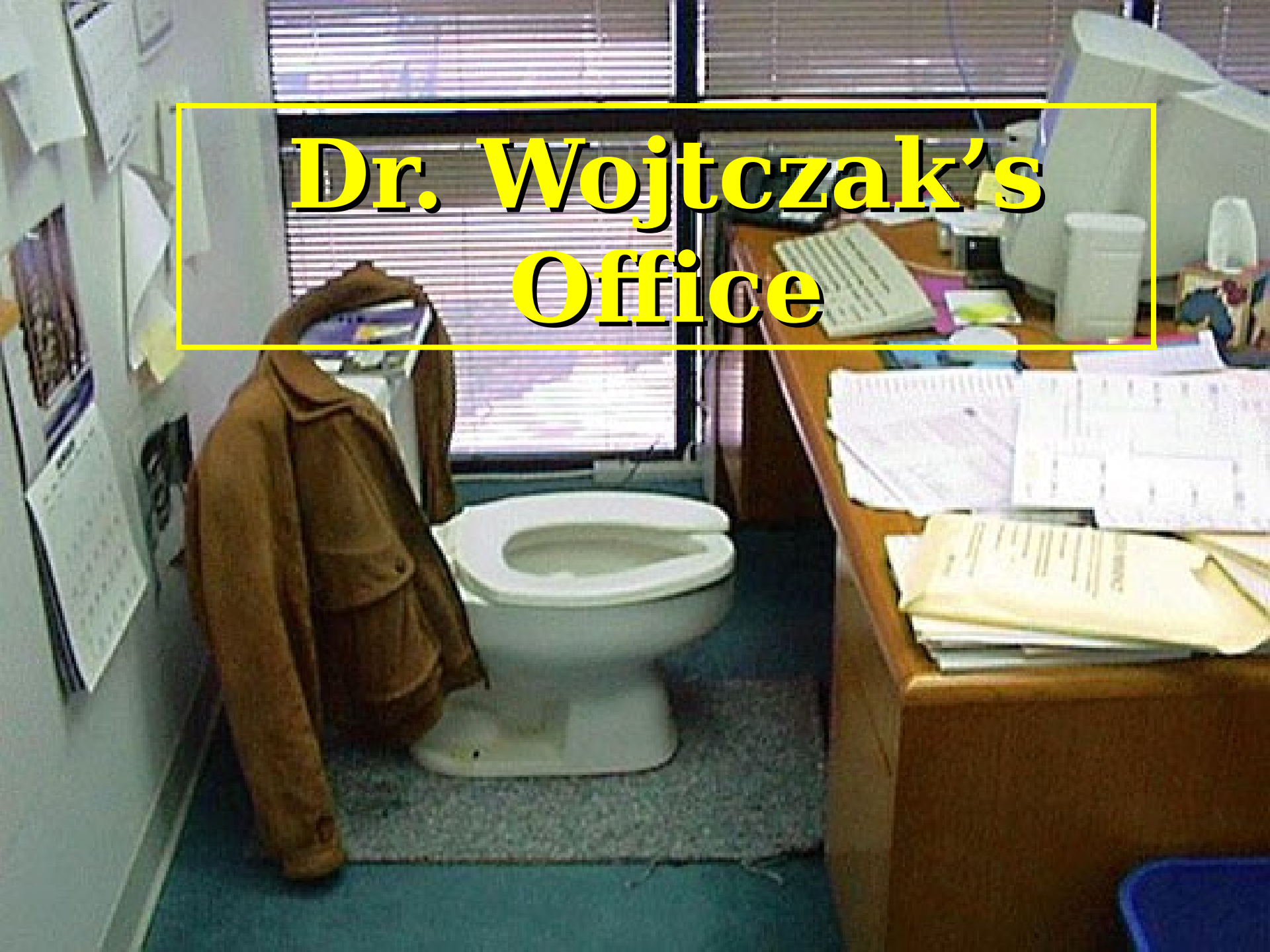
Spirometry

- The measurement of the flow and volume of air entering and leaving the lungs.



Lung Volumes and Capacities

- Dependent upon:
  - Age
  - Body Size (height and weight)
  - Gender
  - Pulmonary Health
  - Altitude
  - Irritants


Dr. Wojtczak's
Office

Simple Office Spirometry

for Primary Care Practitioners

By Thomas L. Petty, MD, and Paul L. Enright, MD

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Static Lung Volumes and Capacities

- Tidal Volume (TV): volume of air inhaled and exhaled at each breath during normal quiet breathing
- Inspiratory Reserve Volume (IRV): Volume of air that can be forcefully inspired following normal quiet inspiration
- Expiratory Reserve Volume (ERV): Volume of air that can be forcefully expired following normal quiet expiration

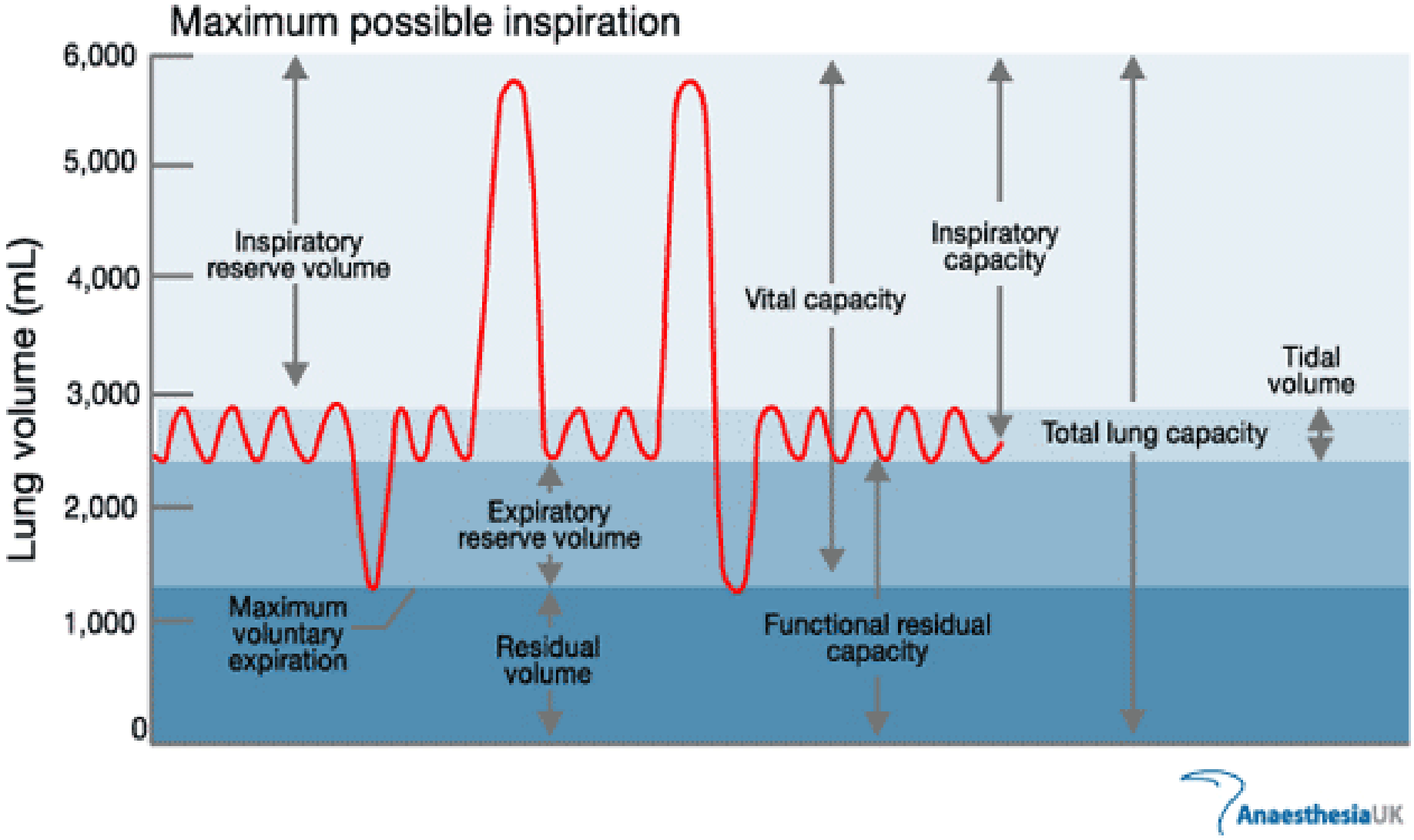
Static Lung Volumes and Capacities

- Vital Capacity (VC): Full volume of air that can be exhaled after a maximal inspiration, IRV+TV+ERV
- Inspiratory Capacity (IC): Max volume of air that can be inhaled after a normal expiration, TV+IRV

Static Lung Volumes and Capacities

- Residual Volume (RV): Volume of air remaining in lungs after forced exhalation
- Total Lung Capacity (TLC): Total volume of the lungs, VC+RV
- Functional Residual Capacity (FRC): Amount of air remaining in the lungs after a normal expiration, ERV+RV
- ***Remember, capacities are always the sum of volumes!

Lung Volumes and Capacities



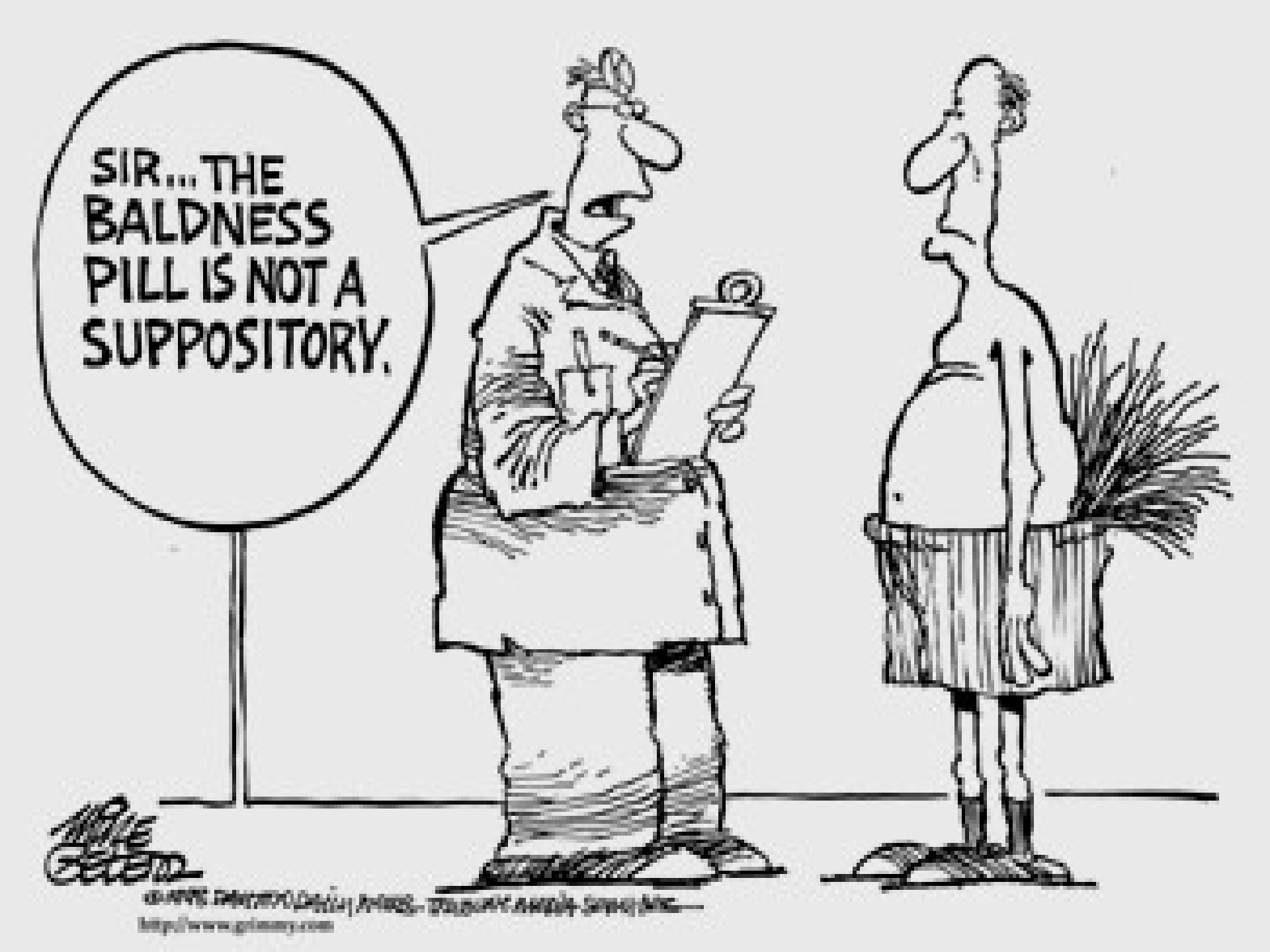
AnaesthesiaUK

Dynamic Lung Volumes

- Valuable in spirometry for following the progress of a patient with chronic lung disease
- Can be used to assess response to treatment
- Help assess preoperative risk
- Do not provide the diagnosis, but can demonstrate if lung function is consistent with a diagnosis (ie, obstructive vs. restrictive disease)

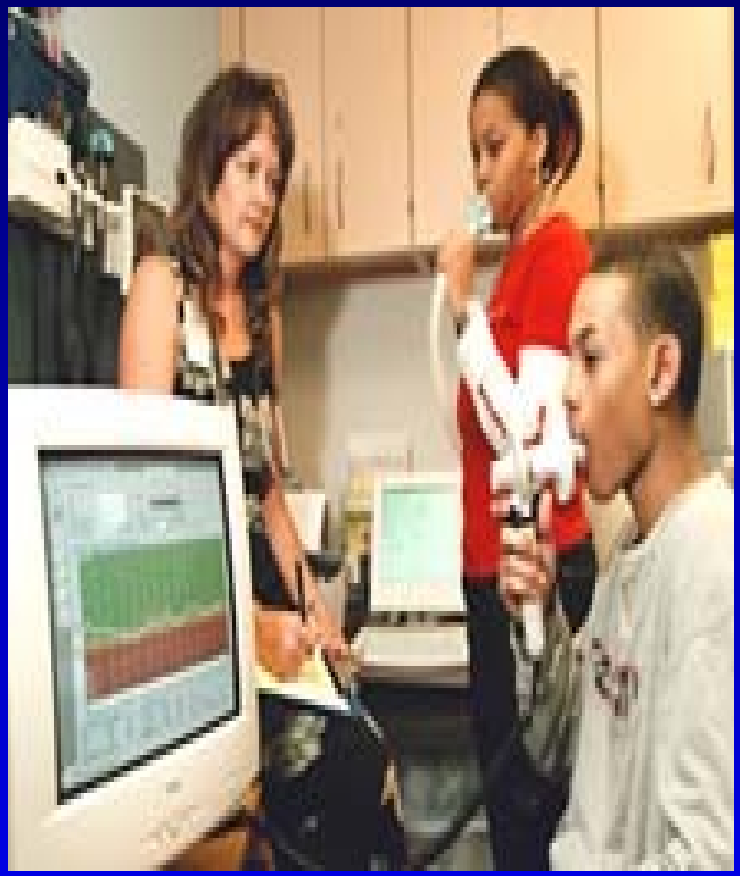
Dynamic Lung Volumes

- Forced Vital Capacity (FVC): Volume expired by a forced maximal expiration after maximal inhalation, also known as FEV_6.
- Forced Exp. Volume in 1 second (FEV_1): Volume of air forcefully expired in the first 1 second from a position of maximal inspiration.
- Forced Exp. Flow from 25-75% of Exhalation, (FEF_{25-75}): Average flow rate during the middle 50% of the FVC maneuver.


SIR... THE BALDNESS PILL IS NOT A SUPPOSITORY.

Administering PFTs in Children

- Requires pt cooperation (unlikely in children less than 5-6 yrs).
- Requires a technician who is sensitive to the needs of children.
- Practice makes perfect!
- Calm, success-oriented environment.



Administering PFTs in Children

- Ask child to take a full breath (to maximal inflation), followed by a brief hold.
- Next, perform a maximal forced exhalation for at least 3 seconds.
- “Blow out all your birthday candles….”

Standards for Testing
Environment

- Torso and head erect either sitting or standing
- Nose clips
- Pretest instruction period:
  - Explain the test (forceful & long expiration)
  - Give demonstration
  - Chance to practice
  - Set a goal
- Coach / Cheerleader

Coaching during testing…

- Perhaps the **MOST** important aspect of testing.
- Deep breath in, BLAST it out, keep blowing, blowing, blowing, DEEP breath in, and that's done!
- Techs should become competent by TAD training, civilian PFT labs, extend out a Medivac to include time in the PFT lab of a major MTF, or manufacturer inservice.

Standards for Testing
Reporting

- Hard copy of results
- All reports include
  - DOB
  - DOT
  - Height
  - Weight
  - Sex
  - Race
  - Absolute values of all measurements
  - Percent of predicted values (Predicted Source)
  - Conditions of test

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Standards for Testing
Guidelines for Interpretation

- Older children and adolescents take the best of 3 tests
- Younger children may require more than 3 tests
- The “best” test is the one with the greatest sum of FEV_1 and FVC

Standards for Testing
Guidelines for Interpretation

- Comment on the quality
- Use FVC, FEV_1, and FEV_1 / FVC % as primary guide for interpretation
- Interpret borderline values with caution
- Primary indicator of obstruction is FEV_1/ FVC %
  - Classify degree of obstruction with % predicted FEV_1
  - Determine response to bronchodilator
- Restriction can be suspected by spirometry but only confirmed with TLC measurement

Data from Taussig LM, Chernick V, Wood R, et al: Standardization of lung function testing in children. J Pediatr 97: 668-676, 1980

Standards for Testing
Technical Requirements for Good Quality

- Full inhalation before start of test
- Satisfactory start of exhalation
  - Evidence of maximal effort
  - No hesitation
- No cough or glottic closure during first second
- Duration of test
  - 3-6 seconds
  - Up to 10 seconds in patients with obstruction
- No evidence of leak
- No evidence of obstruction of mouthpiece

Advantages of FEV_1 Measurement

- Most reproducible
- Comparable between labs
- Reflects changes in lung elastic recoil
- Defines the bronchodilator response
- Best measure of prognosis

Interpreting Results

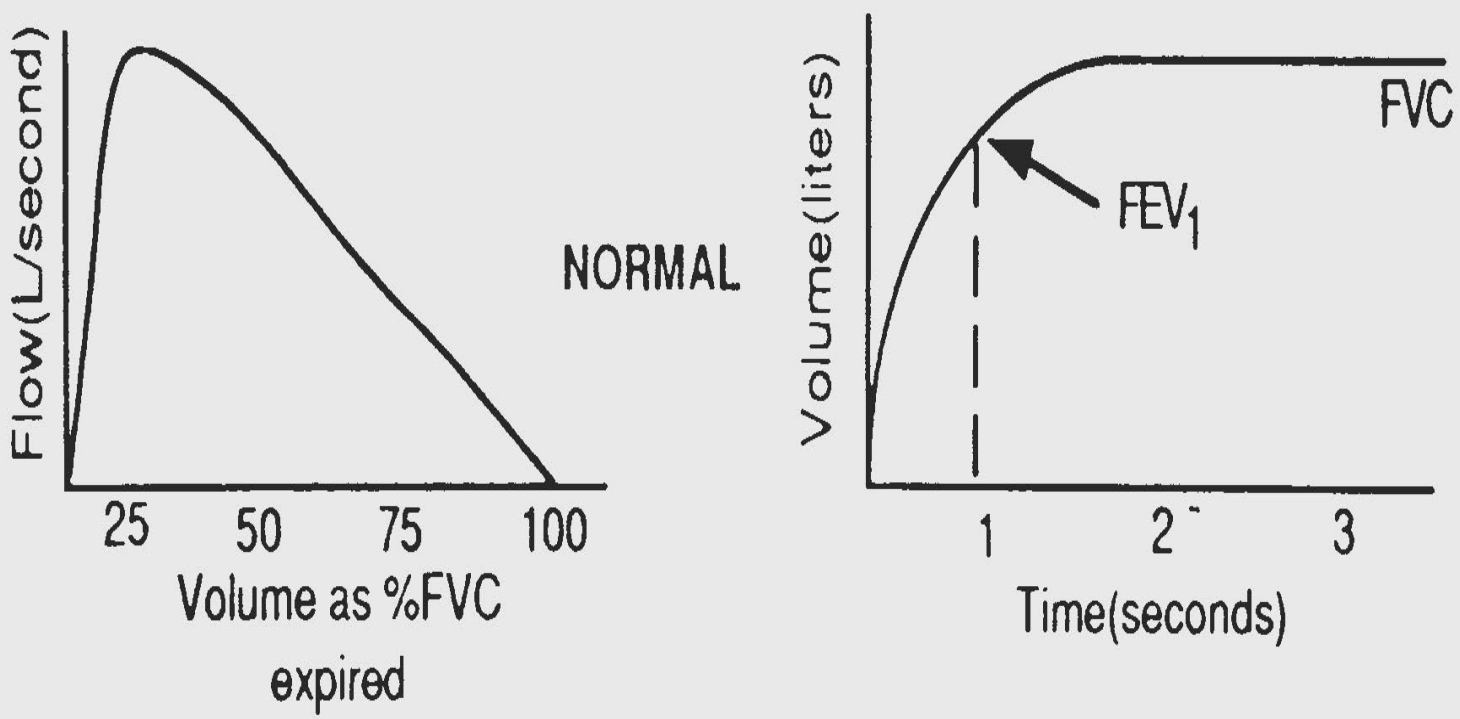
- Spirometry allows comparison of patient's lung function to reference values
- Helps to define disease class: obstructive, restrictive or mixed type

Examples

- Obstructive
  - Asthma
  - CF
  - COPD
  - Foreign Body
  - Tracheomalacia
  - Laryngomalacia
  - Mass Effect
- Restrictive
  - Interstitial lung dz
  - Fibrosis
  - Pneumonitis
  - Sarcoidosis
  - Resection
  - Neuromuscular

Spirometry

Flow Loop- Normal



Spirometry Quality

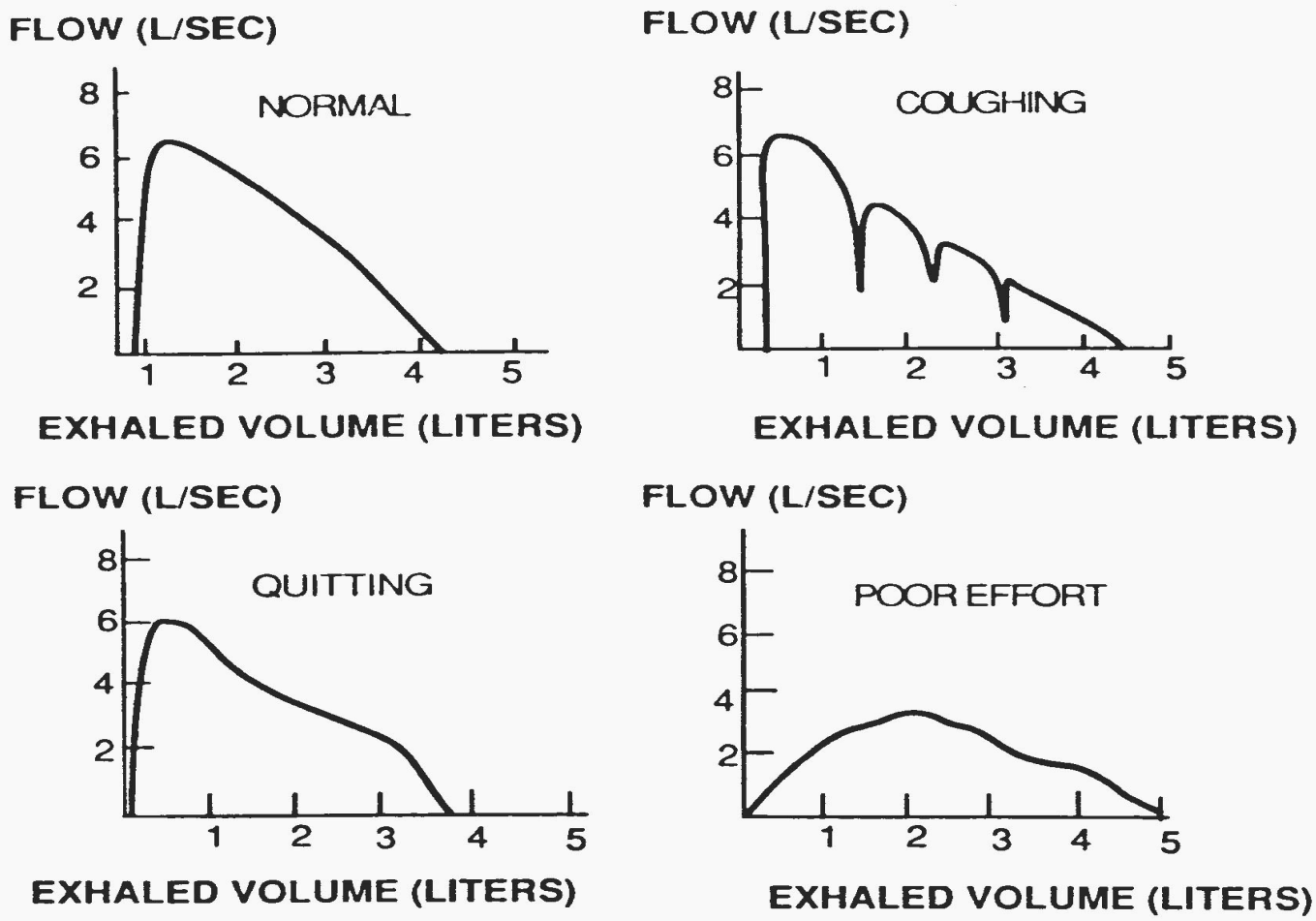
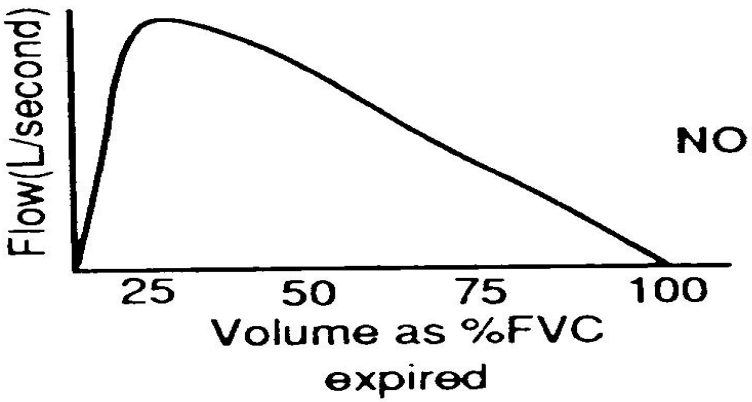
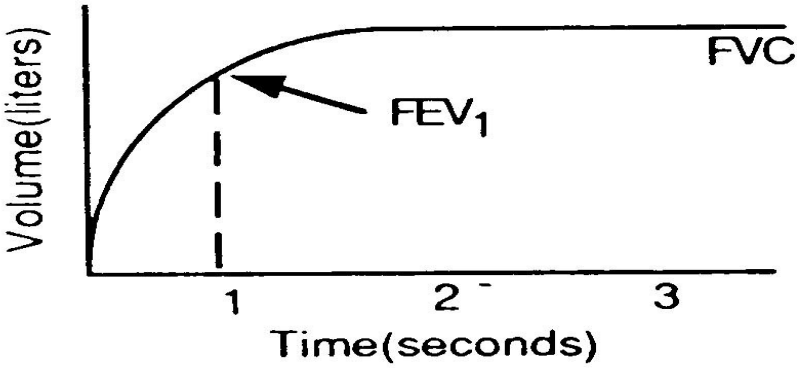
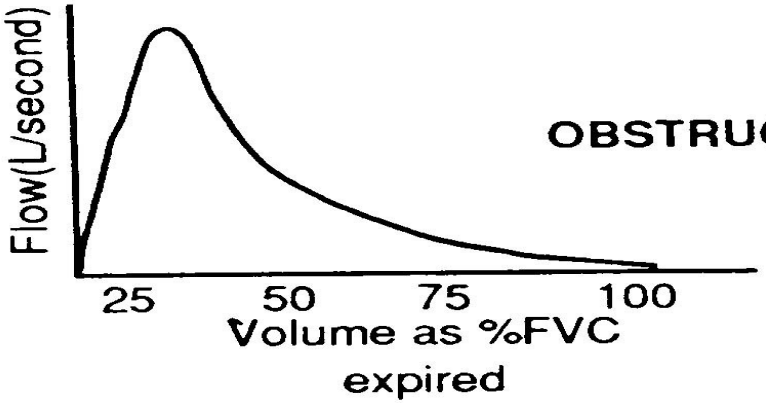


Figure 5. Normal versus inadequate spirometry tracings. The value of pattern recognition cannot be overemphasized in the interpretation of spirometry results.

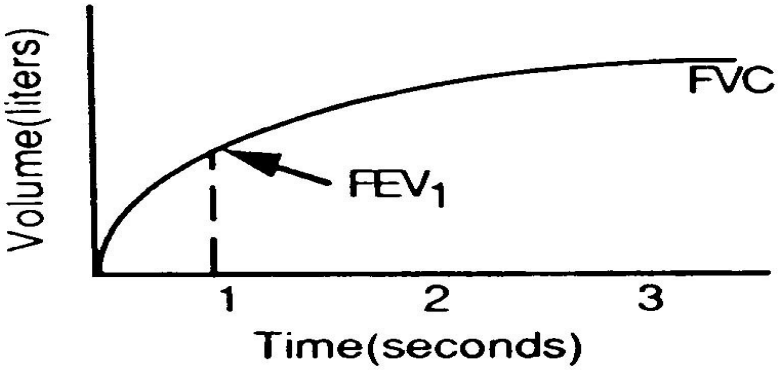


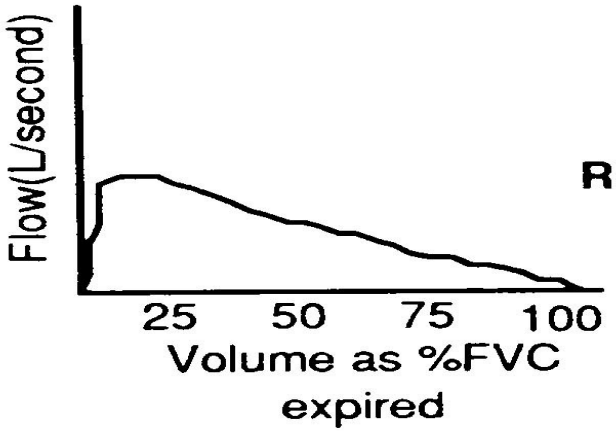
NORMAL



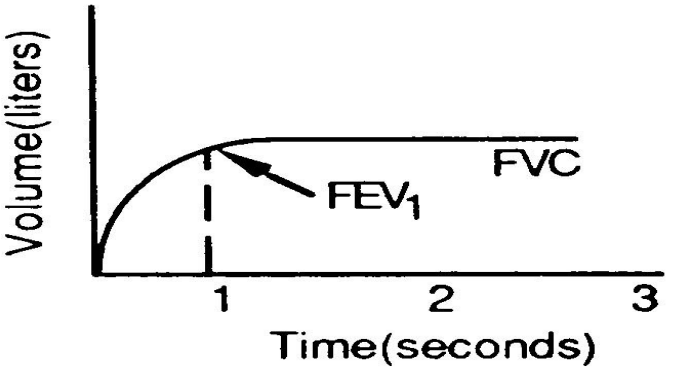


OBSTRUCTIVE



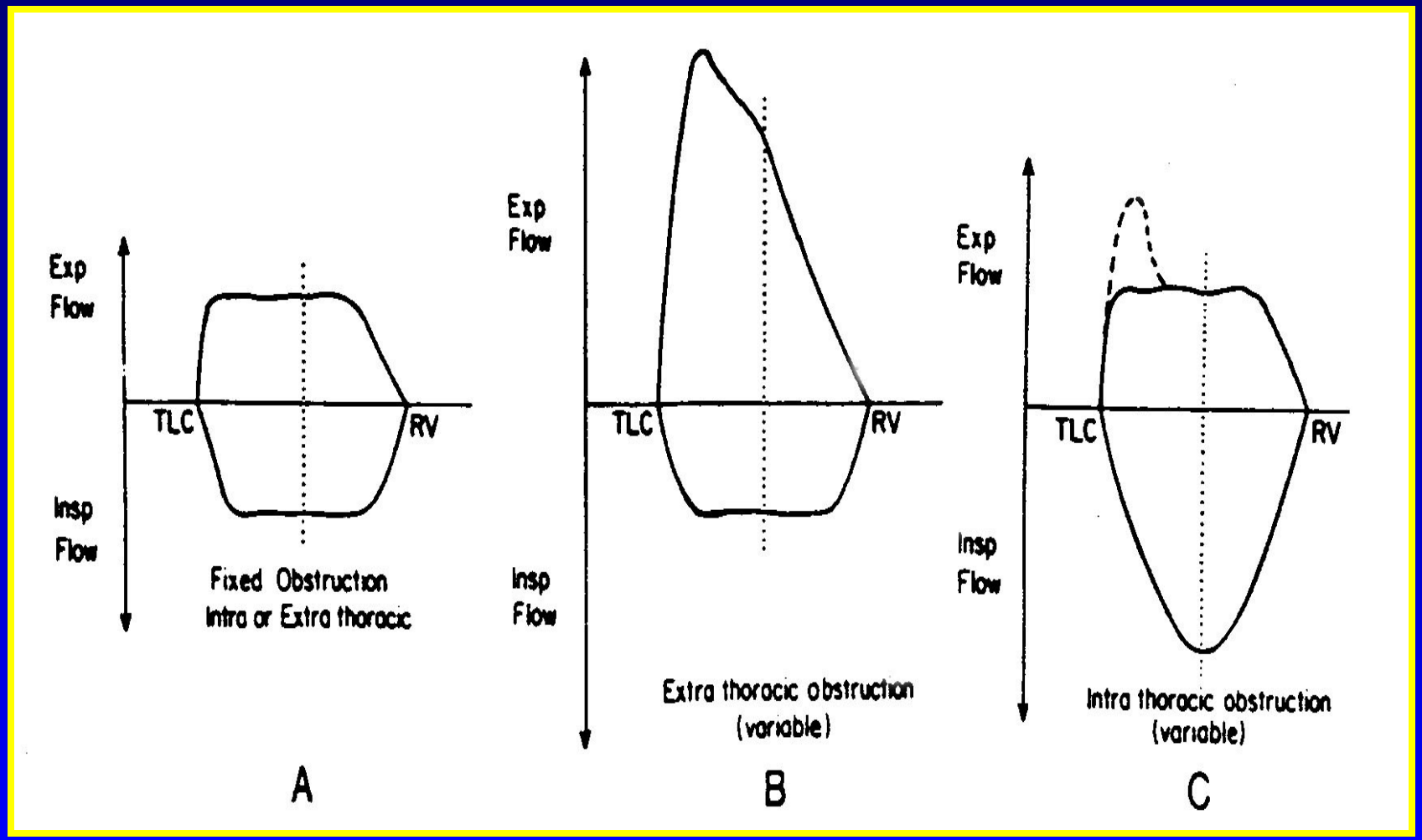


RESTRICTIVE



Flow-Volume Loop Patterns

Large Airway Obstruction



Flow-Volume Curve
Obstructive Lung Disease

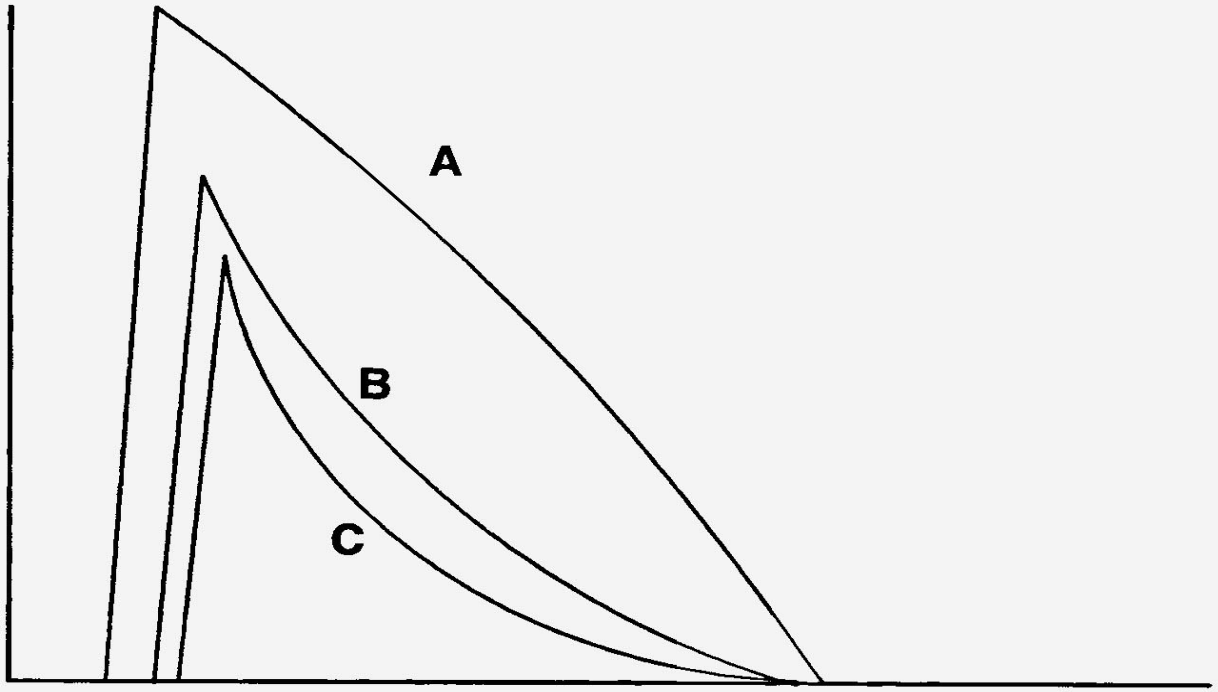
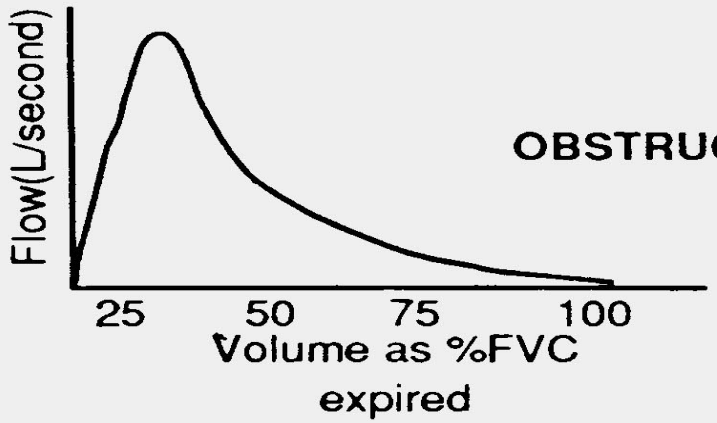
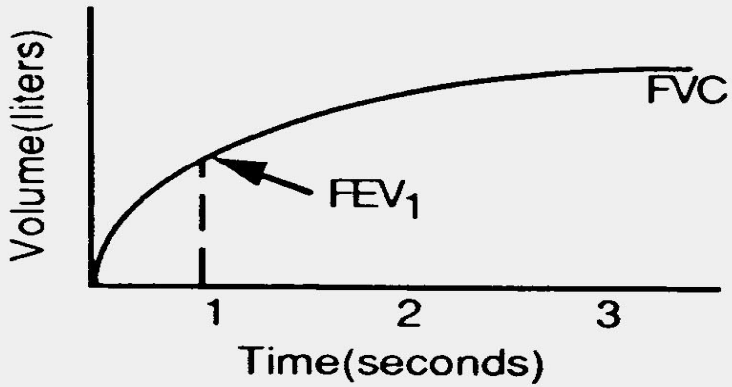


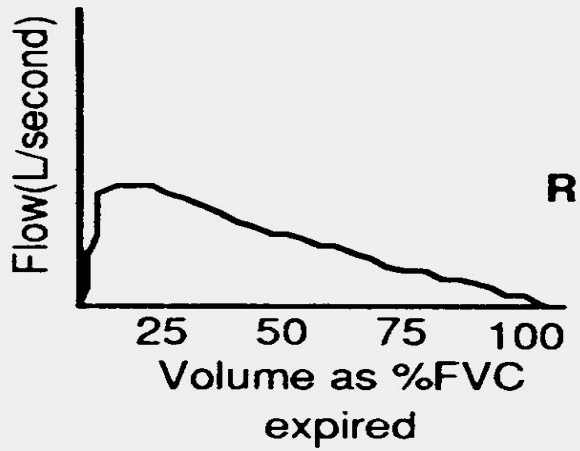
Figure 8.3. *Flow-volume curves with obstructive lung disease.* There is a progressive sag of the mid portion of the flow-volume curve as obstruction increases. Curve *A* is normal with a bowing-out of the cure (convexity) to the X-axis. In curve *B* we see the typical pattern of mild obstructive disease with the curve sagging toward the X-axis. This progresses in curve *C* as obstruction increases. This is a pattern seen in patients with cystic fibrosis as the disease progresses and in children with asthma who are having increasing airways obstruction. In asthma this can be corrected with a bronchodilator given in the laboratory by inhalation.

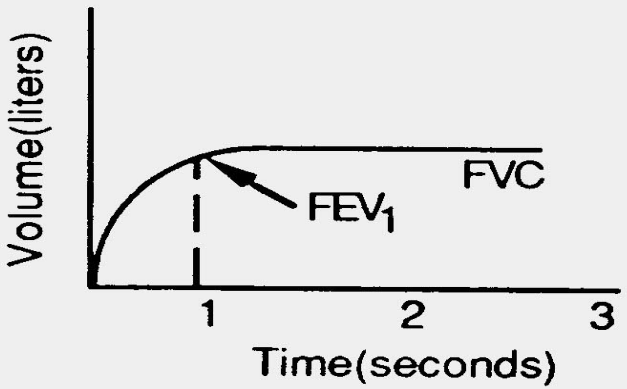
Spirometry

Flow Loop-Abnormal









Are We Going Too Fast?

Longitudinal Lung Function

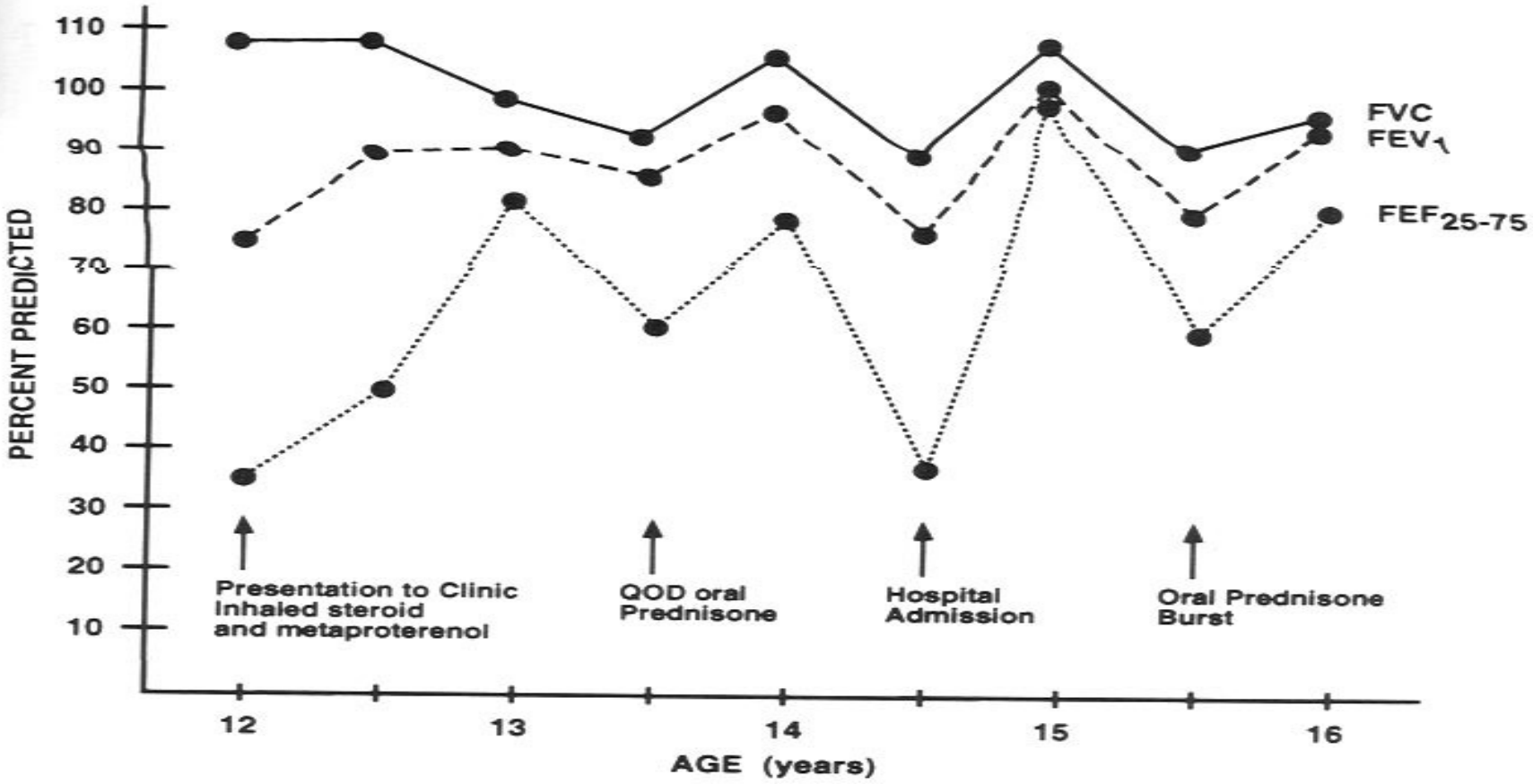


Figure 5. Longitudinal evaluation of lung function is particularly useful in asthma. This patient has significant asthma and has been followed for several years. See text for description of the course of illness. Note that normalization of all three tests could be achieved.

Longitudinal Lung Function

Cystic Fibrosis

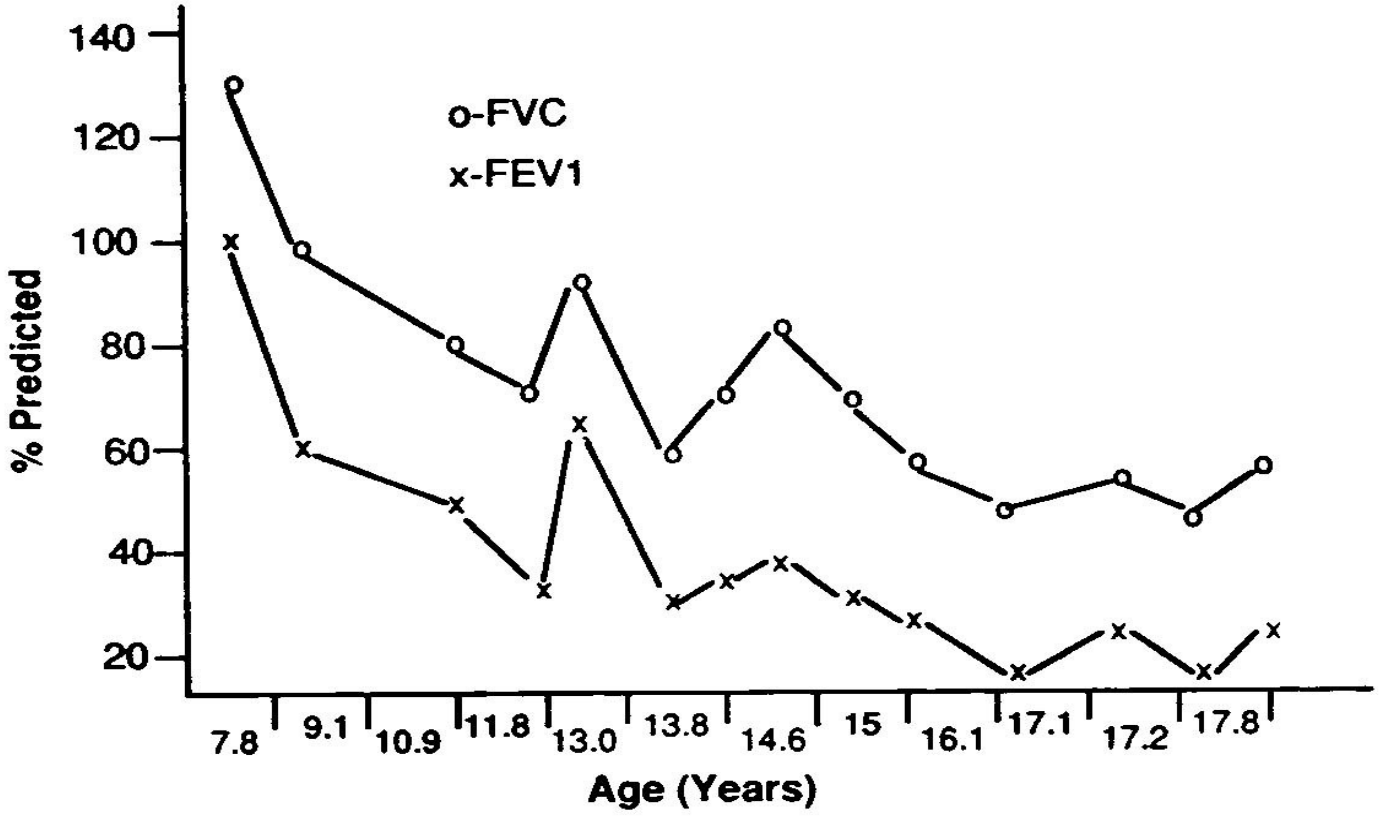
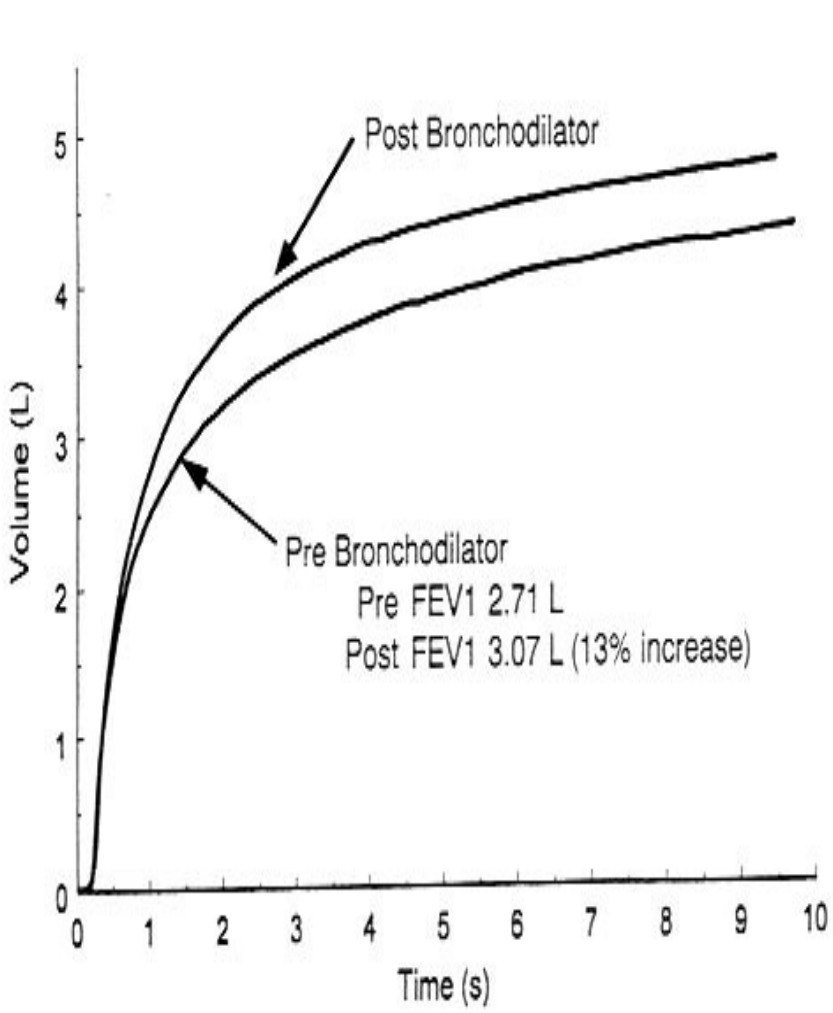
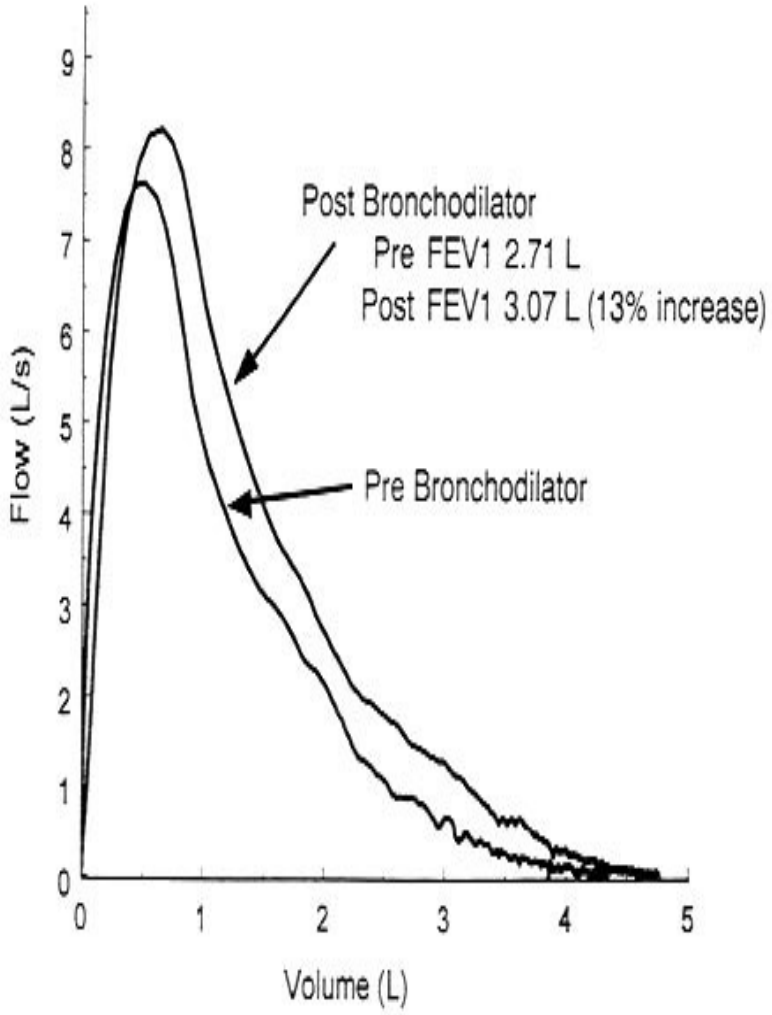


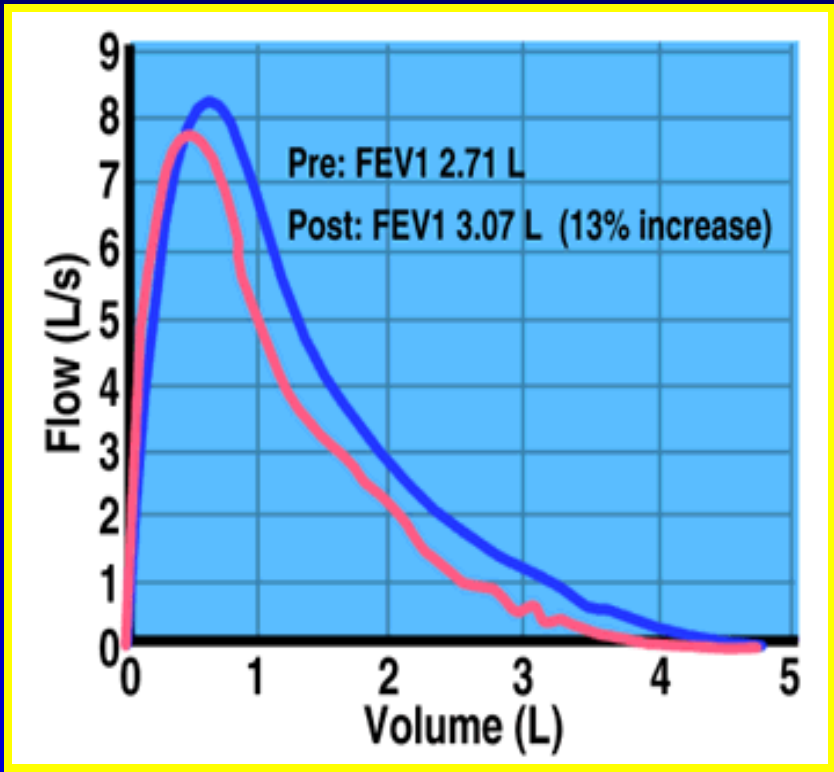
Figure 8. Longitudinal record of spirometry in a male cystic fibrosis patient demonstrating average lung function at age 8 years with a progressive decline through adolescence.

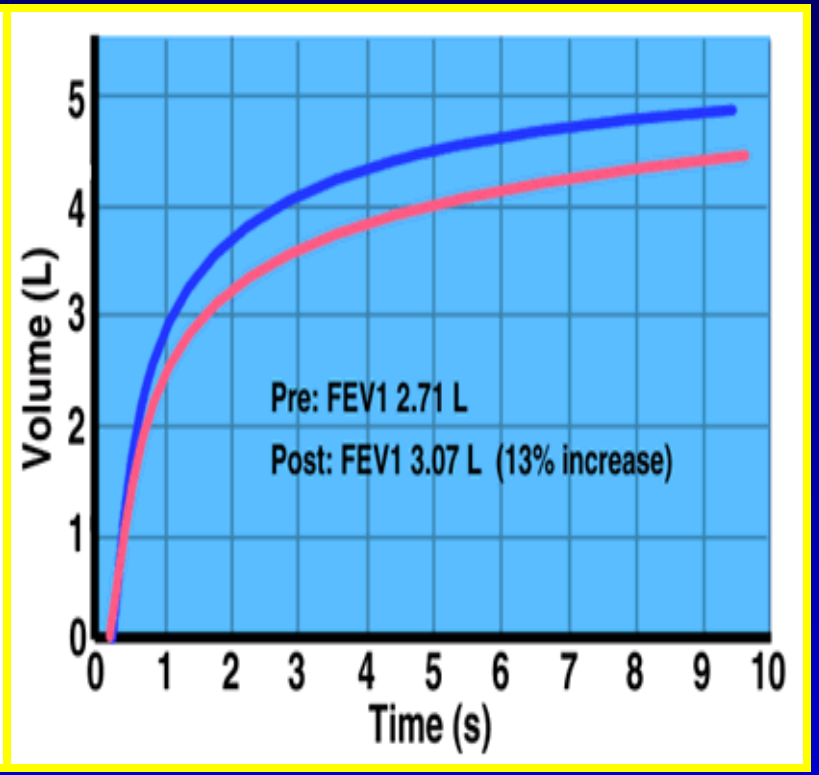
Spirometry Pre / Post Bronchodilator





Pre-Post Bronchodilator





ATS recommends a positive response is > 12% im
in FEV_1

Patterns of Lung Volume Abnormalities

- ***Obstructive***
  - VC: Nl or increased
  - TLC: Increased
  - FRC: Increased
  - RV: Increased
  - RV/TLC: Increased
  - FEV_1: Decreased
  - FVC: Nl or increased
  - FEV_1/FVC: Decreased
- ***Restrictive***
  - VC: Decreased
  - TLC: Decreased
  - FRC: Decreased
  - RV: Decreased
  - RV/TLC: Normal
  - FEV1: Decreased
  - FVC: Decreased
  - FEV_1/FVC: Normal

Role of Spirometry In Asthma

- Spirometry detects the presence of airflow obstruction, defines the severity of airflow limitation, and aids in the differential diagnosis of asthma
- When physical exam findings are not present, mild asthma may be detected by performing spirometry, especially with pre- and post bronhodilator evaluation

Role of Spirometry In Asthma

- Spirometric measures, before and after the administration of a short acting B_2-agonist should be obtained on **all** capable (usually > 5 years-old) patients in whom a diagnosis of asthma is under consideration

- Testing should be performed in compliance with ATS standards

Role of Spirometry In Asthma

- Airflow obstruction can generally be determined by using the forced expiratory volume in the first second (FEV_1) and the forced vital capacity (FVC), and the FEV_1/FVC ratio
- Peak flow should not be used to diagnose asthma because it is less reliable due to poor reproducibility and dependence on patient effort
- Remember there is no single test sufficient or adequate to diagnose asthma

Defining Airway Obstruction

- Airway obstruction is defined as a FEV_1/FVC of < .70 in adults and < .80 in children
- Obstructive defects are characterized by a disproportionate reduction in FEV_1 with respect to FVC
- An FEV_1 < 80% of normal predicted is also suggestive of airflow obstruction
- Airways obstruction may also result in reduction of other measures of airflow, such as mean mid-forced expiratory flow (FEF_{25-75})
- An FEF25-75 which is < 50-60% of predicted normal value is indicative of small airways obstruction

Reversible Airway Obstruction

- Reversible airway obstruction is documented with improvement in FEV_1 of > 12% (usually >200 ml in adults) or clinical improvement in symptoms
- Airway obstruction is considered reversible when FEV_1 has increased > 12% after administration of a B_2 agonist
- Failure to demonstrate a change after bronchodilator does not exclude a reversible component of obstruction because airway inflammation may be present and not responsive to B_2 agonist

Role of Spirometry for Monitoring Asthma

- Every patient capable of spirometry should have testing performed at least every 1-2 years
- All MTFs where asthma care is provided should have access to same day spirometry
- Spirometry also indicated in the following situations:
  - After a change in control therapy to document response
  - When symptom history suggests poor control

Monitoring Pulmonary Function

- Monitoring pulmonary function particularly important for patients who are “poor perceivers”
- Spirometry for initial assessment, after treatment initiated, and every 1-2 years
- Spirometry also helpful as check on accuracy of PF meter, assess response to step down in pharmacotherapy, and when PEF unreliable

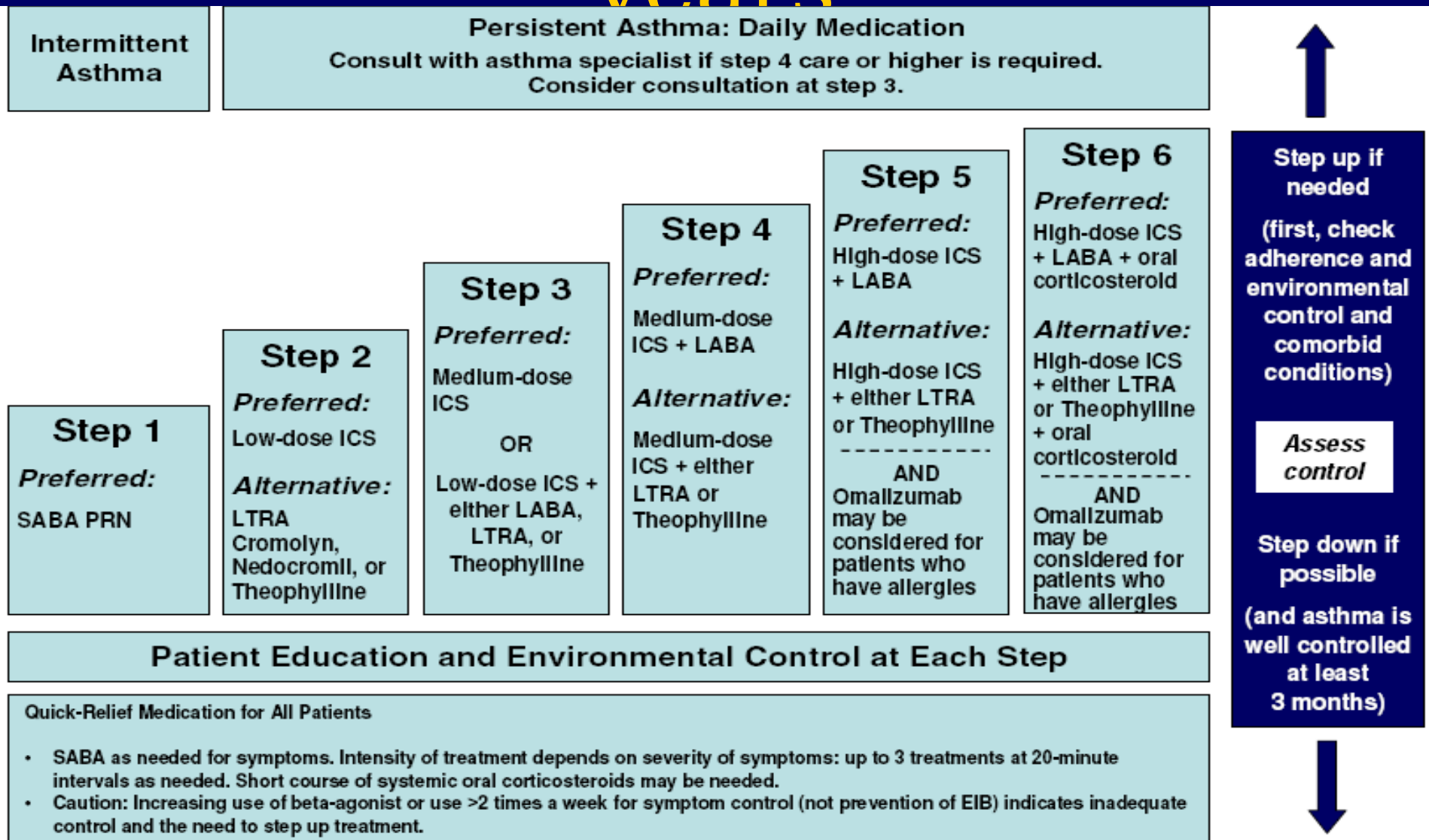
Classification of Asthma Severity: Clinical Features Before Treatment

Components of Severity		Classification of Asthma Severity (5–11 years of age)			
			Persistent		
		Intermittent	Mild	Moderate	Severe
Impairment	Symptoms	≤2 days/week	>2 days/week but not daily	Daily	Throughout the day
	Nighttime awakenings	≤2x/month	3–4x/month	>1x/week but not nightly	Often 7x/week
	Short-acting $beta_2$-agonist use for symptom control (not prevention of EIB)	≤2 days/week	>2 days/week but not daily	Daily	Several times per day
	Interference with normal activity	None	Minor limitation	Some limitation	Extremely limited
	Lung function	• Normal FEV_1 between exacerbations • FEV_1 >80% predicted • FEV_1/FVC >85%	• FEV_1 = >80% predicted • FEV_1/FVC >80%	• FEV_1 = 60–80% predicted • FEV_1/FVC = 75–80%	• FEV_1 <60% predicted • FEV_1/FVC <75%
Risk	Exacerbations (consider frequency and severity)	0–2/year	>2 in 1 year		
		Frequency and severity may fluctuate over time for patients in any severity category			
		Relative annual risk of exacerbations may be related to FEV_1			
Recommended Step for Initiating Therapy (See figure 4-1b for treatment steps.)		Step 1	Step 2	Step 3, medium-dose ICS option and consider short course of systemic oral corticosteroids	Step 3, medium-dose ICS option, or step 4
		In 2–6 weeks, evaluate level of asthma control that is achieved, and adjust therapy accordingly.			

Stepwise Approach to Therapy: Assessing Control (5-11 yo)

Components of Control		Classification of Asthma Control (5–11 years of age)		
		Well Controlled	**Not Well Controlled**	**Very Poorly Controlled**
Impairment	Symptoms	≤2 days/week but not more than once on each day	>2 days/week or multiple times on ≤2 days/week	Throughout the day
	Nighttime awakenings	≤1x/month	≥2x/month	≥2x/week
	Interference with normal activity	None	Some limitation	Extremely limited
	Short-acting $beta_2$-agonist use for symptom control (not prevention of EIB)	≤2 days/week	>2 days/week	Several times per day
	Lung function • FEV_1 or peak flow • FEV_1/FVC	 >80% predicted/ personal best >80% predicted	 60–80% predicted/ personal best 75–80% predicted	 <60% predicted/ personal best <75% predicted
Risk	**Exacerbations**	0–1 per year	2–3 per year	>3 per year
	Reduction in lung growth	Evaluation requires long-term followup.		
	Treatment-related adverse effects	Medication side effects can vary in intensity from none to very troublesome and worrisome. The level of intensity does not correlate to specific levels of control but should be considered in the overall assessment of risk.		
Recommended Action for Treatment **(See figure 4-1b for treatment steps.)**		• Maintain current step. • Regular followup every 3–6 months. • Consider step down if well controlled for at least 3 months.	• Step up at least 1 step and • Reevaluate in 2–6 weeks. • For side effects: consider alternative treatment options.	• Consider short course of systemic oral corticosteroids, • Step up 1–2 steps, and • Reevaluate in 2 weeks. • For side effects: consider alternative treatment options.

“Step Therapy” Age 5-11 years


Intermittent Asthma
Persistent Asthma: Daily Medication
Consult with asthma specialist if step 4 care or higher is required.
Consider consultation at step 3.
Step 1
Preferred:
SABA PRN
Step 2
Preferred:
Low-dose ICS
Alternative:
LTRA
Cromolyn, Nedocromil, or Theophylline
Step 3
Preferred:
Medium-dose ICS
OR
Low-dose ICS + either LABA, LTRA, or Theophylline
Step 4
Preferred:
Medium-dose ICS + LABA
Alternative:
Medium-dose ICS + either LTRA or Theophylline
Step 5
Preferred:
High-dose ICS + LABA
Alternative:
High-dose ICS + either LTRA or Theophylline
AND
Omalizumab may be considered for patients who have allergies
Step 6
Preferred:
High-dose ICS + LABA + oral corticosteroid
Alternative:
High-dose ICS + either LTRA or Theophylline + oral corticosteroid
AND
Omalizumab may be considered for patients who have allergies
Step up if needed
(first, check adherence and environmental control and comorbid conditions)
Assess control
Step down if possible
(and asthma is well controlled at least 3 months)
Patient Education and Environmental Control at Each Step
Quick-Relief Medication for All Patients
• SABA as needed for symptoms. Intensity of treatment depends on severity of symptoms: up to 3 treatments at 20-minute intervals as needed. Short course of systemic oral corticosteroids may be needed.
• Caution: Increasing use of beta-agonist or use >2 times a week for symptom control (not prevention of EIB) indicates inadequate control and the need to step up treatment.

Hang in There….Almost Finished!

Case Study: *Randy*

- **History**
  - **6-year-old male with a history of asthma since infancy**
  - **States that he never coughs or wheeze during the day, and maybe 1 night/month especially at night**
  - **Currently on an ICS, Flovent 44 ug 2p BID with MPAC**
  - **Does not perceive his asthma as limiting his activity, but has difficulty keeping up with his friends due to wheezing**
  - **Parents believe that his asthma is well controlled**
- **Physical exam**
  - **Normal vital signs**
  - **Chest: No wheezes or prolonged expiratory phase**
  - **Heart: Normal**
- **Spirometry**
  - **FEV_1: 60% of predicted**

Interpreted by:

Physician: Wojtczak MD Predicted set: Hankinson (NHANES III)

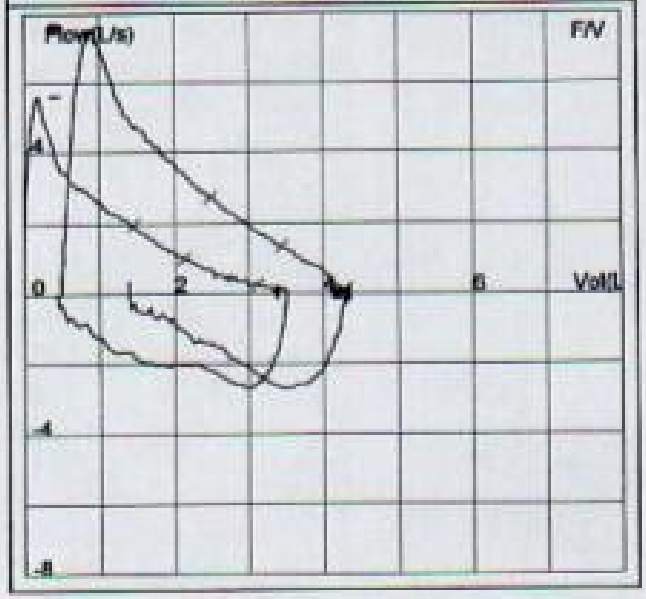
Technician: Gary Krumwiede RRT, AE-C Bronchodilator: 3 puffs Xopenex pMDI & VHC

Test comments (Pre): Test comments (Post):

Results

Result	Pred	Pre	%Prd	Post	%Prd	%Chg	
FVC (L)	4.18	3.51	84%	3.82	91%	9%	
FEV.5 (L)	—	1.48	—	2.13	—	45%	
FEV1 (L)	3.61	¤2.15	60%	3.02	84%	40%	
FEV1/FVC	0.85	¤0.61	72%	0.79	93%	29%	
FEF25-75% (L/s)	3.98	¤1.20	30%	2.61	66%	117%	
PEFR (L/s)	7.63	¤5.01	66%	7.16	94%	43%	
PIFR (L/s)	—	2.66	—	—	—	—	—
Vext %	—	0.43	—	1.60	—	270%	
Exp time (s)	—	5.80	—	—	—	—	—

FVC Flow vs. Volume

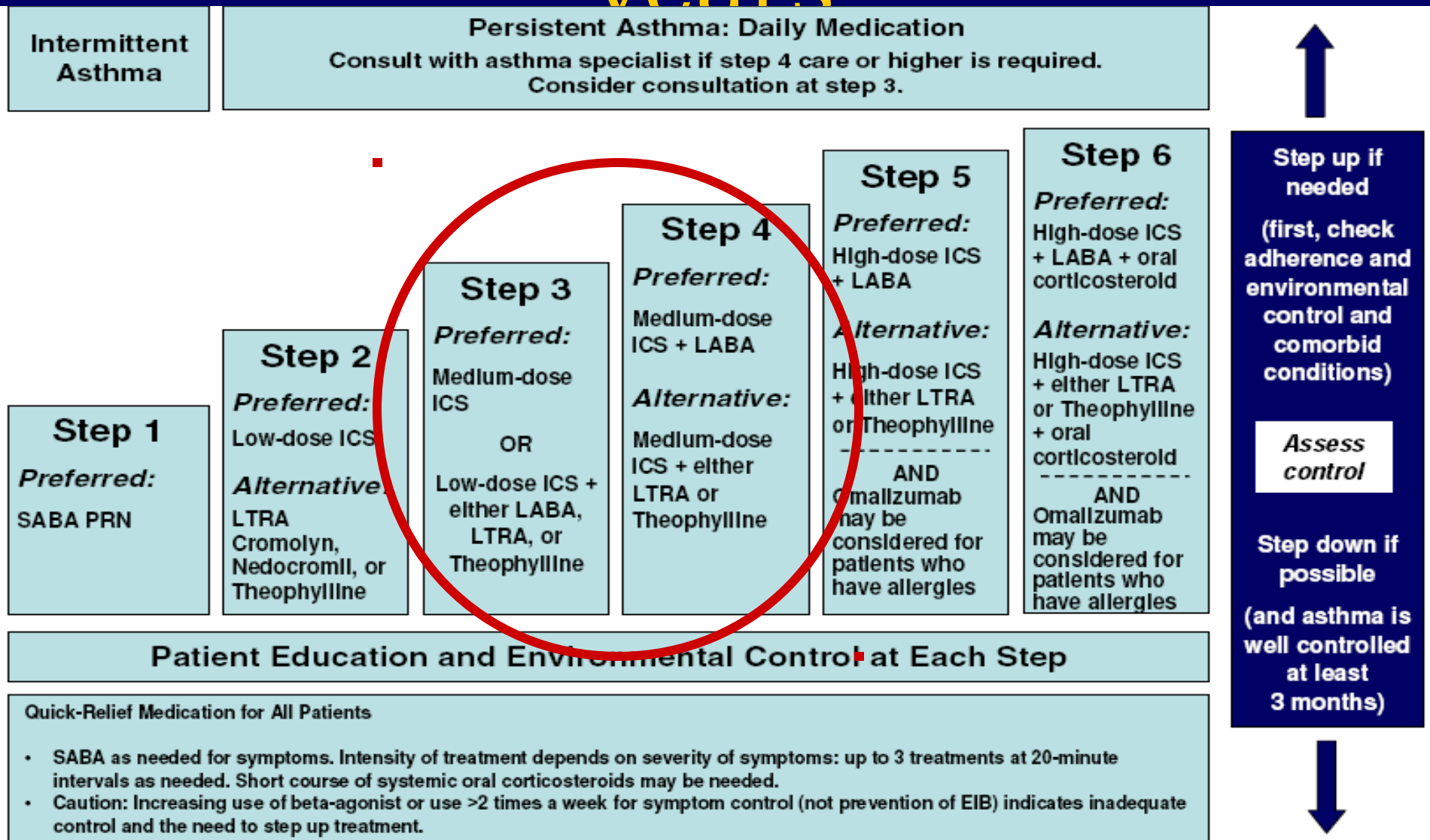


FVC Volume vs. Time

Stepwise Approach to Therapy: Assessing Control (5–11 yo)

Components of Control		Classification of Asthma Control (5–11 years of age)		
		Well Controlled	**Not Well Controlled**	**Very Poorly Controlled**
Impairment	Symptoms	≤2 days/week but not more than once on each day	>2 days/week or multiple times on ≤2 days/week	Throughout the day
	Nighttime awakenings	≤1x/month	≥2x/month	≥2x/week
	Interference with normal activity	None	Some limitation	Extremely limited
	Short-acting $beta_2$-agonist use for symptom control (not prevention of EIB)	≤2 days/week	>2 days/week	Several times per day
	Lung function • FEV_1 or peak flow • FEV_1/FVC	 >80% predicted/ personal best >80% predicted	 60–80% predicted/ personal best 75–80% predicted	 <60% predicted/ personal best <75% predicted
Risk	**Exacerbations**	**0–1 per year**	**2–3 per year**	**>3 per year**
	Reduction in lung growth	Evaluation requires long-term followup.		
	Treatment-related adverse effects	Medication side effects can vary in intensity from none to very troublesome and worrisome. The level of intensity does not correlate to specific levels of control but should be considered in the overall assessment of risk.		
Recommended Action for Treatment **(See figure 4-1b for treatment steps.)**		• Maintain current step. • Regular followup every 3–6 months. • Consider step down if well controlled for at least 3 months.	• Step up at least 1 step and • Reevaluate in 2–6 weeks. • For side effects: consider alternative treatment options.	• Consider short course of systemic oral corticosteroids, • Step up 1–2 steps, and • Reevaluate in 2 weeks. • For side effects: consider alternative treatment options.

“Step Therapy” Age 5-11 years


Intermittent Asthma
Persistent Asthma: Daily Medication
Consult with asthma specialist if step 4 care or higher is required.
Consider consultation at step 3.
Step 1
Preferred:
SABA PRN
Step 2
Preferred:
Low-dose ICS
Alternative:
LTRA
Cromolyn, Nedocromil, or Theophylline
Step 3
Preferred:
Medium-dose ICS
OR
Low-dose ICS + either LABA, LTRA, or Theophylline
Step 4
Preferred:
Medium-dose ICS + LABA
Alternative:
Medium-dose ICS + either LTRA or Theophylline
Step 5
Preferred:
High-dose ICS + LABA
Alternative:
High-dose ICS + either LTRA or Theophylline
AND
Omalizumab may be considered for patients who have allergies
Step 6
Preferred:
High-dose ICS + LABA + oral corticosteroid
Alternative:
High-dose ICS + either LTRA or Theophylline + oral corticosteroid
AND
Omalizumab may be considered for patients who have allergies
Step up if needed
(first, check adherence and environmental control and comorbid conditions)
Assess control
Step down if possible
(and asthma is well controlled at least 3 months)
Patient Education and Environmental Control at Each Step
Quick-Relief Medication for All Patients
• SABA as needed for symptoms. Intensity of treatment depends on severity of symptoms: up to 3 treatments at 20-minute intervals as needed. Short course of systemic oral corticosteroids may be needed.
• Caution: Increasing use of beta-agonist or use >2 times a week for symptom control (not prevention of EIB) indicates inadequate control and the need to step up treatment.

Child
Abuse ???

Spirometry in Primary Care

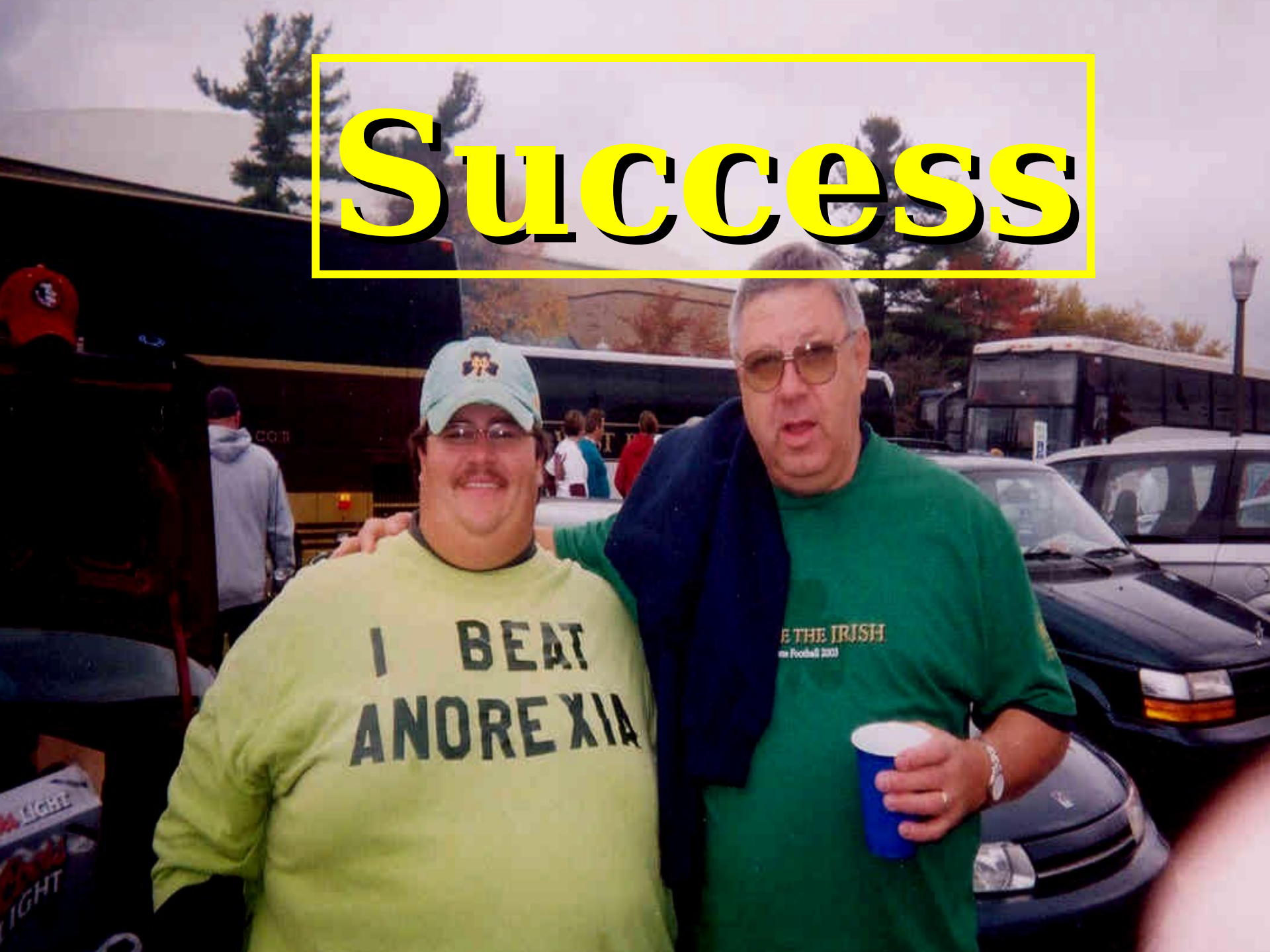
- “Should play a central role any time a physician prescribes potent bronchoactive and anti-inflammatory drugs…”
- An objective measure of airway obstruction, restriction

Petty, T.L. “Benefits of and Barriers to the Widespread Use Current Opinions in Pulm Medicine, 2005, 11:115-120.

Spirometry in Primary Care

- Quality of studies in PC setting: 85 of 109 (78%) tests administered met all criteria for acceptability and reproducibility (reviewed by peds pulm)
- Good agreement between pediatricians office testing and lab testing
- Interpretation: Pediatrician was incorrect in 23 of 109 test (21%)

Zanconato, S. "Office Spirometry in Primary Care Pediatrics: A P
Pediatrics, December 2005, 116; 792-797.


Success
I BEAT
ANOREXIA

Summary

- Spirometry is an important diagnostic tool which should be used in the primary care setting.
- Requires proper training for physicians, nurses, techs.
- Portable spirometry equipment produces quality studies and allows for testing in PC setting.

The End!!!!!!

Questions and
Comments !!!!

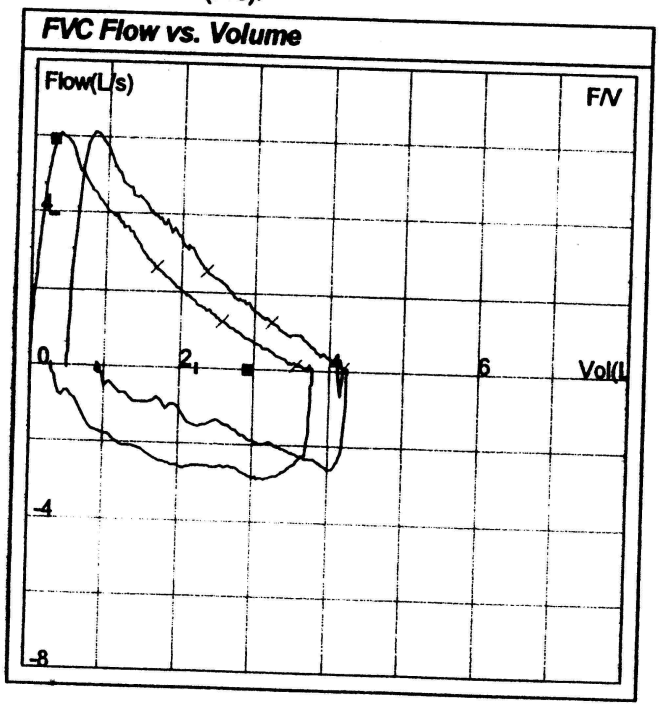
Captain W
and His Crew
CHARGIN'
FORWARD
to find a cure!

CAPT MC, USN
PEDIATRIC PULMONOLOGY

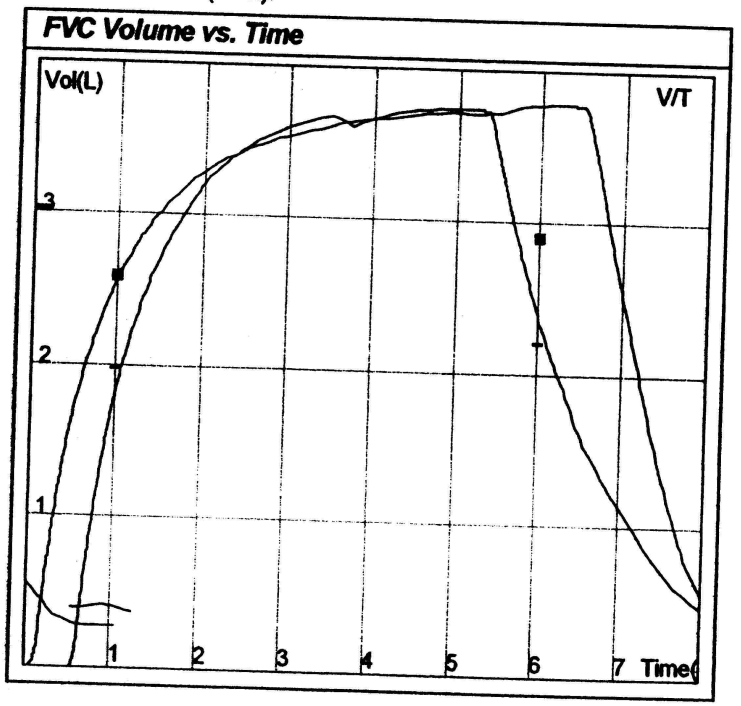
Results

Result	Pred	Pre	%Prd	Post	%Prd	%Chg
FVC (L)	2.92	3.71	127%	3.74	128%	1%
FEV1 (L)	2.59	2.70	104%	2.82	109%	4%
FEV1/FVC	0.89	¤0.73	82%	¤0.75	85%	4%
FEF25-75% (L/s)	3.22	2.03	63%	2.28	71%	12%
PEFR (L/s)	5.93	6.09	103%	6.16	104%	1%
PIFR (L/s)	—	2.89	—	—	—	— —
Vext %	—	2.08	—	1.71	—	-18%
Exp time (s)	—	5.15	—	—	—	— —

Test comments (Pre):



Test comments (Post):

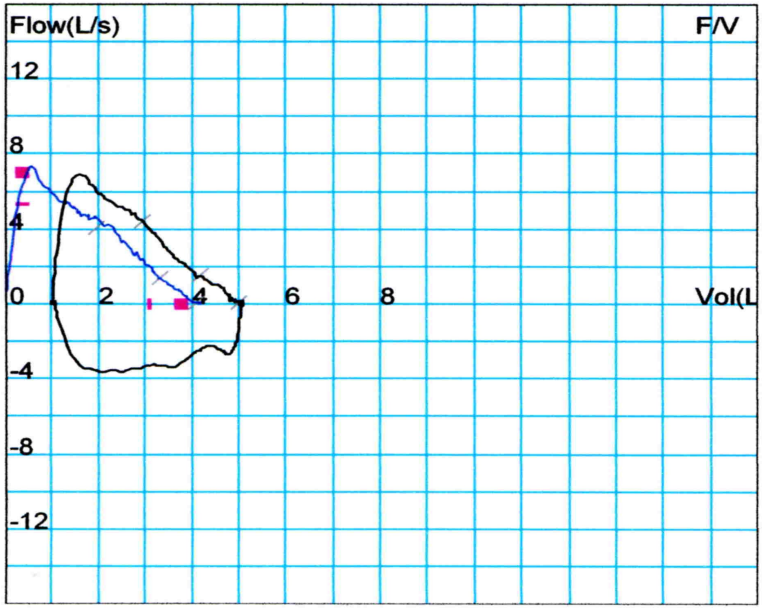


NMCSD Peds Pulmonary Pre vs. Post Report

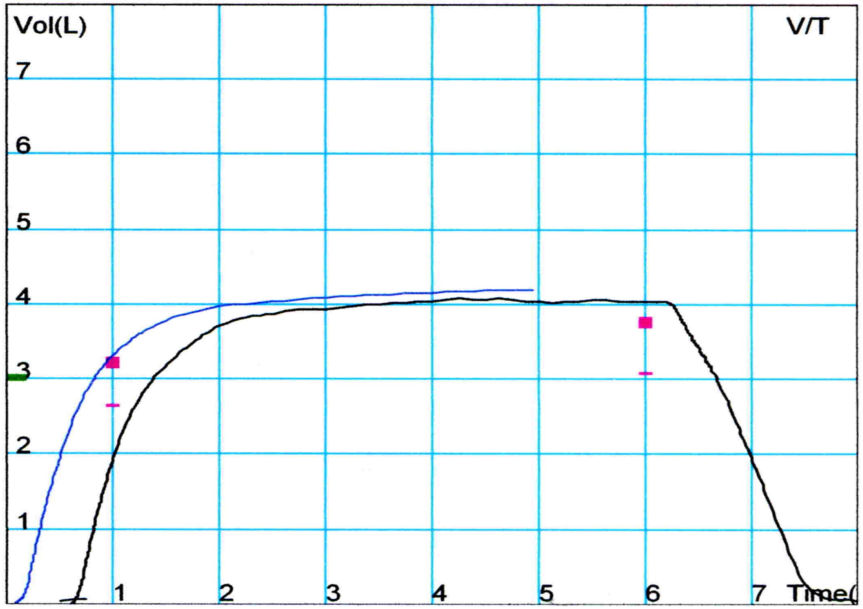
Results

Result	Pred	Best	%Prd	Cons	%Prd		%Prd
FVC (L)	3.78	4.20	111%	4.08	108%	---	---
FEV1 (L)	3.22	3.52	109%	3.40	106%	---	---
FEV1/FVC	0.85	0.84	99%	0.83	98%	---	---
FEF25-75% (L/s)	3.52	3.68	105%	3.45	98%	---	---
PEFR (L/s)	6.98	7.37	106%	6.89	99%	---	---
PIFR (L/s)	---	---	---	3.68	---	---	---
Vext %	---	2.94	---	2.67	---	---	---
Exp time (s)	---	4.78	---	3.96	---	---	---

FVC Flow vs. Volume



FVC Volume vs. Time



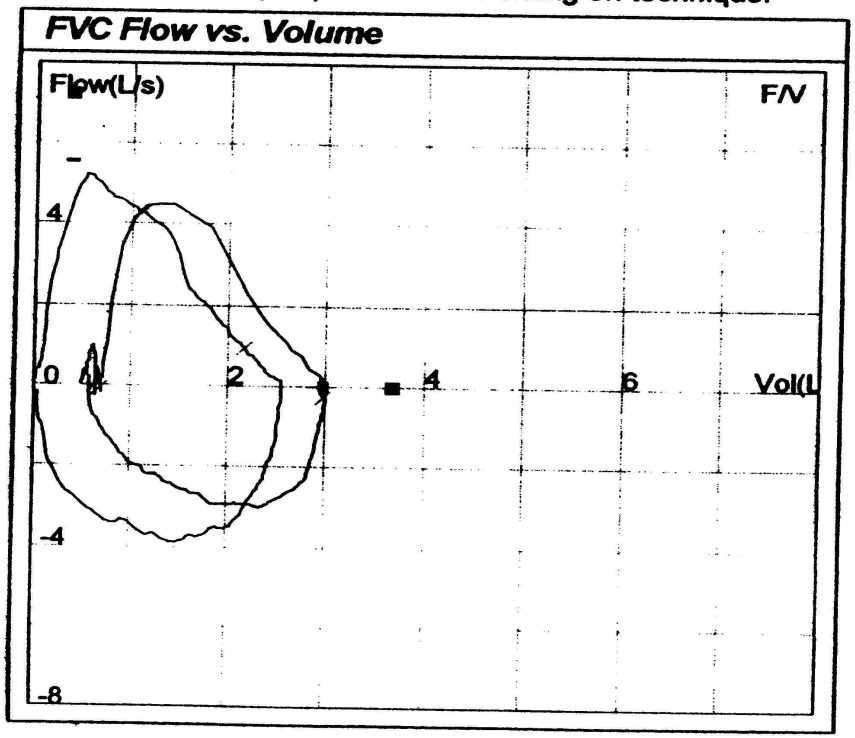
NMCSD Peds Pulmonary Screener

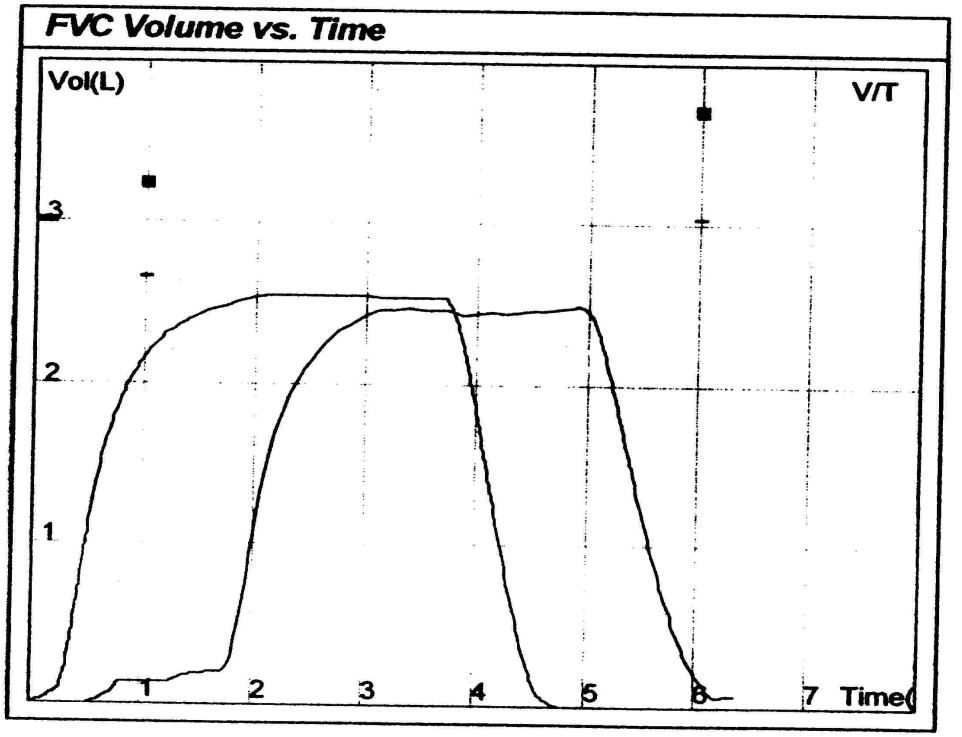
Results

Result	Pred	Pre	%Prd	Post	%Prd	%Chg
FVC (L)	3.68	¤2.56	70%	¤2.43	66%	-5%
FEV1 (L)	3.24	¤2.36	73%	¤2.34	72%	-1%
FEV1/FVC	0.84	0.92	109%	0.96	114%	4%
FEF25-75% (L/s)	3.83	3.20	84%	3.45	90%	8%
PEFR (L/s)	7.23	¤5.22	72%	¤4.56	63%	-13%
PIFR (L/s)	—	3.91	—	—	—	— —
Vext %	—	5.43	—	9.68	—	78%
Exp time (s)	—	2.37	—	—	—	— —

Test comments (Pre): First PFT working on technique.

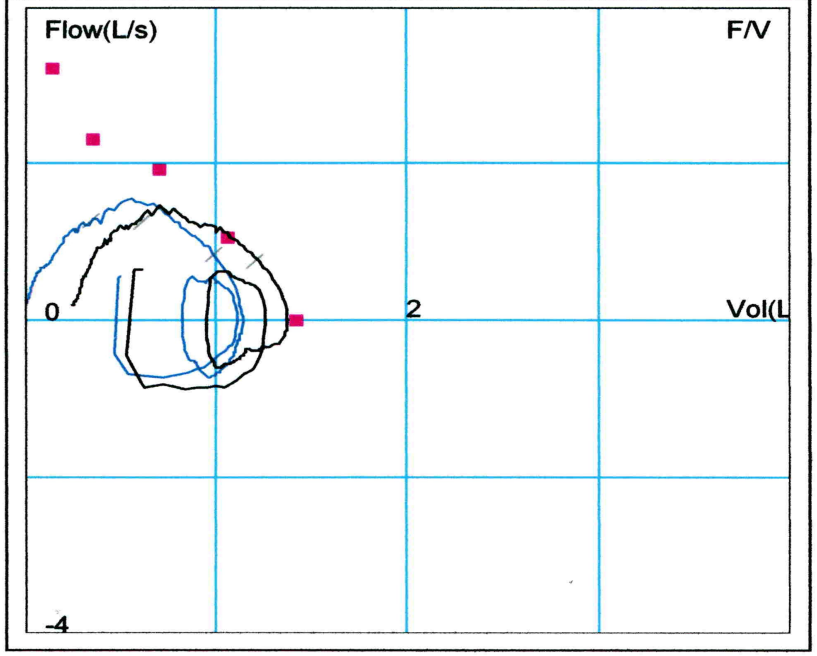
Test comments (Post):



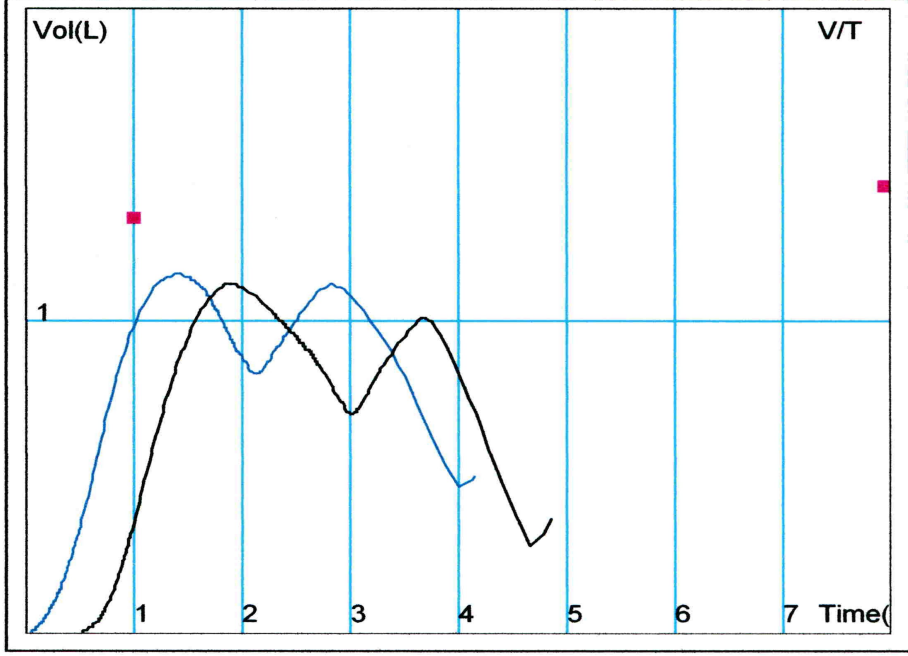


Result	Pred	Best	%Prd	Cons	%Prd		%Prd
FVC (L)	1.43	1.15	81%	1.12	79%	---	---
FEV1 (L)	1.33	1.14	86%	1.10	83%	---	---
FEV1/FVC	0.86	0.99	115%	0.98	114%	---	---
FEF25-75% (L/s)	1.69	1.36	80%	1.27	75%	---	---
PEFR (L/s)	3.22	1.55	48%	1.48	46%	---	---
PIFR (L/s)	3.25	0.75	23%	0.89	27%	---	---
Vext %	---	11.30	---	8.53	---	---	---
Exp time (s)	---	1.12	---	1.13	---	---	---

FVC Flow vs. Volume



FVC Volume vs. Time



NMCSD Peds Pulmonary Screener

Physician: Wojtczak MD

Predicted set: Hankinson (NHANES III)

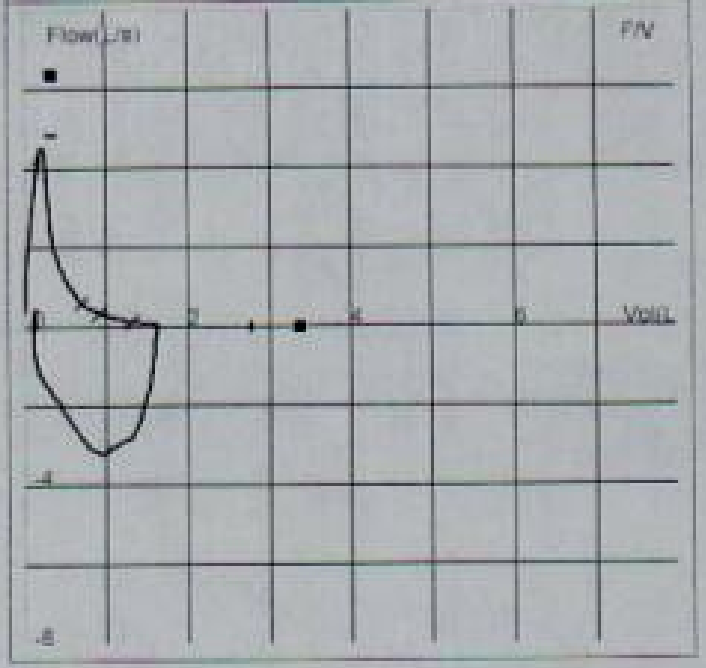
Technician: Gary Knutsede RRT AE-C

Test comments:

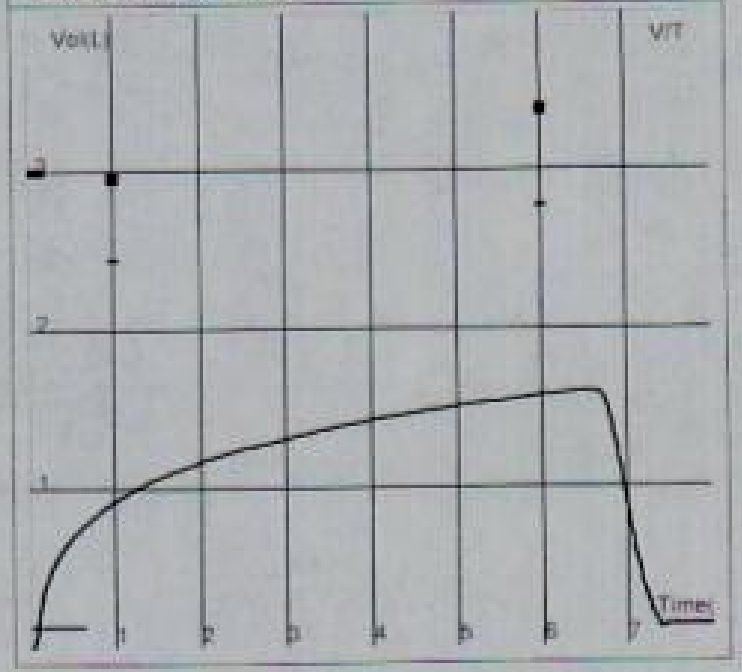
Results

Result	Pred	Best	%Pred				
FVC (L)	**3.37**	**¤1.61**	**48%**	—	—	—	—
FEV.5 (L)	—	0.73	—	—	—	—	—
FEV1 (L)	**2.96**	**¤0.94**	**32%**	—	—	—	—
FEV1/FVC	**0.86**	**¤0.58**	**68%**	—	—	—	—
FEF25-75% (L/s)	**3.47**	**¤0.40**	**11%**	—	—	—	—
PEFR (L/s)	**6.37**	**¤4.49**	**71%**	—	—	—	—
PIFR (L/s)	—	3.20	—	—	—	—	—
Vext %	—	1.41	—	—	—	—	—
Exp time (s)	—	6.45	—	—	—	—	—

FVC Flow vs. Volume



FVC Volume vs. Time



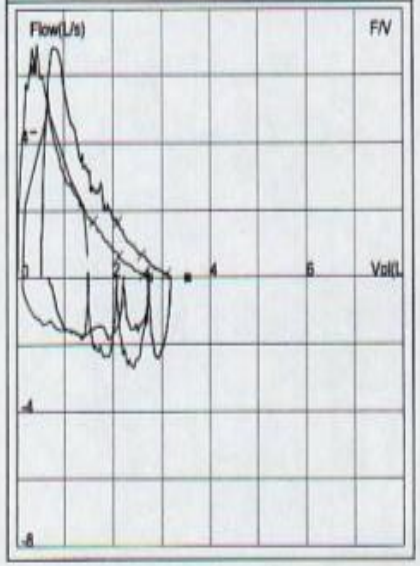
Physician: Wojtczak MD Predicted set: Hankinson (NHANES III)

Technician: Gary Krumwiede RRT, AE-C Test comments: Last tx @ 1400 2 puffs Xopenex

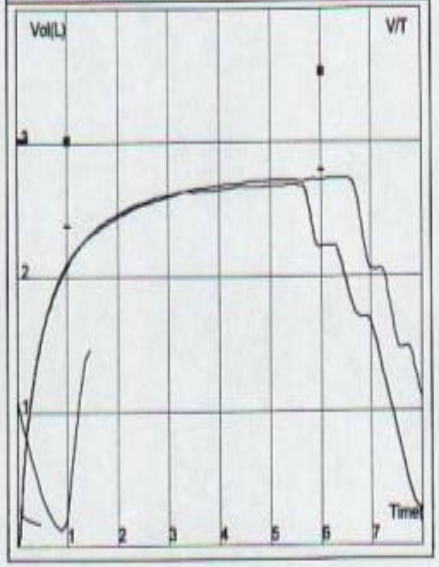
Results

Result	Pred	Best	%Prd	Cons	%Prd		%Prd
FVC (L)	3.53	¤2.72	77%	¤2.66	75%	—	—
FEV.5 (L)	—	1.64	—	1.62	—	—	—
FEV1 (L)	3.02	¤2.12	70%	¤2.10	70%	—	—
FEV1/FVC	0.86	0.78	91%	0.79	92%	—	—
FEF25-75% (L/s)	3.24	¤1.79	55%	¤1.81	56%	—	—
PEFR (L/s)	6.21	6.91	111%	6.67	107%	—	—
PIFR (L/s)	—	2.62	—	2.38	—	—	—
Vext %	—	1.81	—	1.43	—	—	—
Exp time (s)	—	5.03	—	4.16	—	—	—

FVC Flow vs. Volume



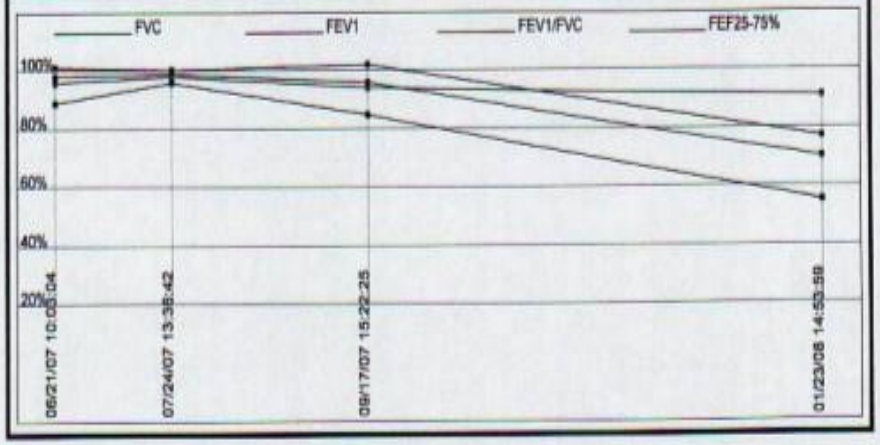
FVC Volume vs. Time



NMCSD Peds Pulmonary Pre-Rx Trend Report

Page 1 of 2

Spirometry History, Pre-Rx %Predicted

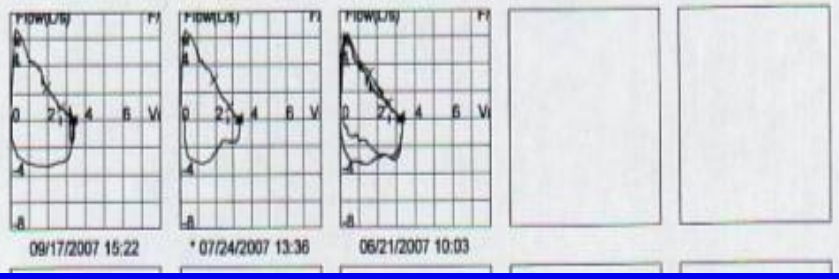


Trend Results

Test series date	FVC	%Prd	FEV1	%Prd	FEV1/FVC%	%Prd	FEF25-75%	%Prd	PEFR	%Prd
01/23/2008 14:53	¤2.72	77%	¤2.12	70%	0.78	91%	¤1.79	55%	6.91	111%
09/17/2007 15:22	3.44	102%	2.76	98%	0.80	94%	2.59	85%	6.76	115%
* 07/24/2007 13:36	3.38	100%	2.84	99%	0.84	98%	2.91	96%	6.71	114%
06/21/2007 10:03	3.34	101%	2.74	98%	0.82	96%	2.66	89%	6.11	106%
	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—

* Reference test series

Flow vs. Volume History



Mild obstruction and no D p
BD. FEV1/FVC - 71%

Day 7/10 po steroids

Interpreted by: Henry A. Wojtczak, M.D.
CAPT MC, USN
PEDIATRIC PULMONOLOGY

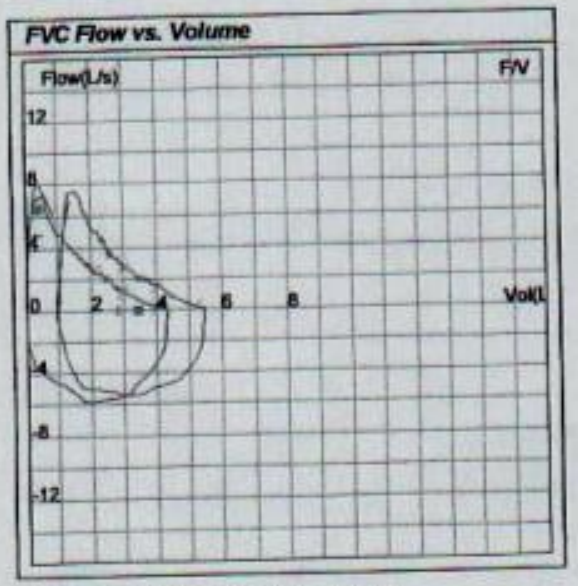
Physician: Wojtczak MD Predicted set: Hankinson (NHANES III)

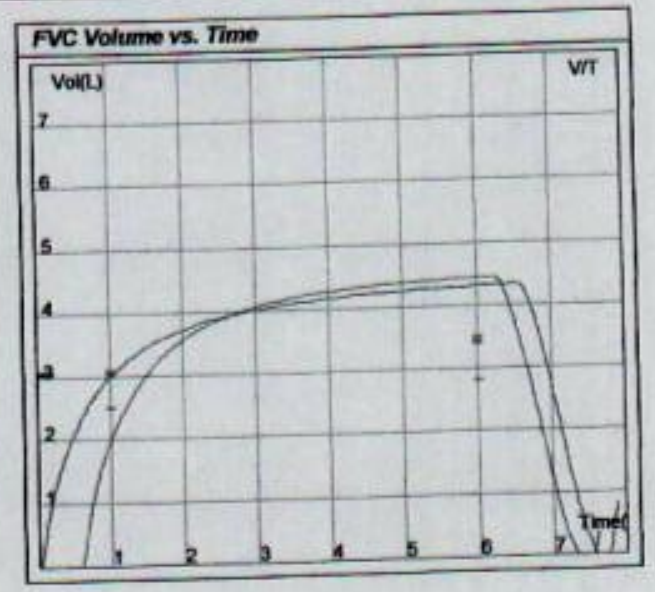
Technician: Gary Krumwiede RRT, AE-C Bronchodilator: 3 puffs Xopenex pMDI & VHC

Test comments (Pre): Test comments (Post):

Results

Result	Pred	Pre	%Prd	Post	%Prd	%Chg
FVC (L)	3.46	4.30	124%	4.45	129%	3%
FEV.5 (L)	—	2.19	—	2.25	—	2%
FEV1 (L)	3.06	3.04	99%	3.16	103%	4%
FEV1/FVC	0.87	¤0.71	81%	¤0.71	81%	0%
FEF25-75% (L/s)	3.70	¤2.13	58%	¤2.25	61%	6%
PEFR (L/s)	6.45	8.06	125%	7.56	117%	-6%
PIFR (L/s)	—	5.81	—	—	—	— —
Vext %	—	1.08	—	1.46	—	36%
Exp time (s)	—	5.60	—	—	—	— —





NMCSD Peds Pulmonary Pre vs. Post Report

Interpreted by:

Physician: Wojtczak MD Predicted set: Hankinson (NHANES III)

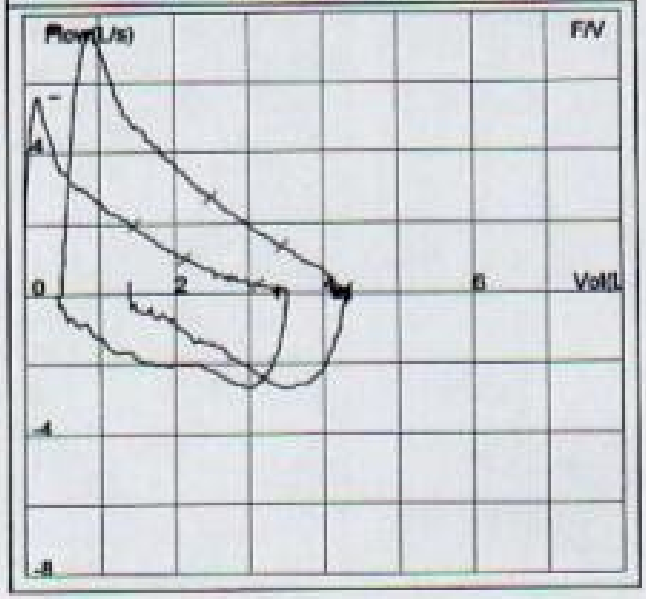
Technician: Gary Krumwiede RRT, AE-C Bronchodilator: 3 puffs Xopenex pMDI & VHC

Test comments (Pre): Test comments (Post):

Results

Result	Pred	Pre	%Prd	Post	%Prd	%Chg	
FVC (L)	4.18	3.51	84%	3.82	91%	9%	
FEV.5 (L)	—	1.48	—	2.13	—	45%	
FEV1 (L)	3.61	¤2.15	60%	3.02	84%	40%	
FEV1/FVC	0.85	¤0.61	72%	0.79	93%	29%	
FEF25-75% (L/s)	3.98	¤1.20	30%	2.61	66%	117%	
PEFR (L/s)	7.63	¤5.01	66%	7.16	94%	43%	
PIFR (L/s)	—	2.66	—	—	—	—	—
Vext %	—	0.43	—	1.60	—	270%	
Exp time (s)	—	5.80	—	—	—	—	—

FVC Flow vs. Volume



FVC Volume vs. Time